International Black-Footed Ferret Recovery Workshop

1-4 April 2005
Calgary, Alberta, Canada

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FINAL REPORT

Photos courtesy of United States Fish & Wildlife Service.

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Additional copies of *International Black-Footed Ferret Recovery Workshop: Final Report* can be ordered through the IUCN/SSC Conservation Breeding Specialist Group, 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, USA (www.cbsg.org)

Black-Footed Ferret (*Mustela nigripes*)
International Recovery Workshop
Final Report

Calgary, Alberta, Canada
1 – 4 April, 2005

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International Black-Footed Ferret Recovery Workshop

Executive Summary

Introduction

The black-footed ferret is among the most endangered mammals of North America. In the 1950s, ferrets were still thought to occur in low densities throughout most of their historic range. By the 1960s, the only known population of black-footed ferrets was a small colony in southwestern South Dakota. That colony was studied from its discovery in 1964 until it disappeared in 1974 for unknown reasons. With the disappearance of the South Dakota colony, biologists feared the species was extinct, or existed in such small populations that natural disaster or disease would eventually eliminate them. In 1981, a black-footed ferret was killed by a ranch dog in northwestern Wyoming. This event led to the dramatic discovery of a small population of about 130 ferrets near Meeteetse, Wyoming in 1984. Research conducted on the Meeteetse ferrets provided valuable information on the life history and behavior of this secretive mammal. Tragically, outbreaks of sylvatic plague and canine distemper killed nearly all of the Meeteetse population. The remaining 18 ferrets were taken to a captive breeding facility in hopes of supporting future conservation efforts for the species. In 1987, a captive-breeding program was initiated by the U.S. Fish and Wildlife Service, the Wyoming Game and Fish Department, and the American Zoo and Aquarium Association.

Since 1991, United States federal and state agencies, in cooperation with private landowners, conservation groups, Native Americans, and the North American zoo community, have been actively reintroducing ferrets to the wild. Beginning in Wyoming, reintroduction efforts have since expanded to sites in Montana, South Dakota, and Arizona. Proposed reintroduction sites have been identified in Colorado and Utah. The U.S. Recovery Plan for the black-footed ferret calls for the establishment of 10 or more separate, self-sustaining wild populations. By the year 2010, biologists hope to have 1500 ferrets established in the wild, with no fewer than 30 breeding adults in each population. If these objectives are met, the ferret could be downlisted from endangered to threatened status in the States. However, additional obstacles to this overall objective remain and must be systematically evaluated if black-footed ferret conservation in the wild is to succeed.

Ferret recovery efforts are also underway in Canada. The Canadian Species At Risk Act (SARA), passed in June 2003, requires recovery strategies to be developed for Extirpated, Endangered and Threatened species. A recovery strategy for black-footed ferrets is required by June 2007. In response to this need, a group of experts gathered in June 2004 in Val Marie, Saskatchewan to discuss the feasibility and potential value of ferret reintroductions in Grasslands National Park and surrounding areas in southern Saskatchewan. Workshop participants concluded that recovery of the species in this area may be feasible, and recommended the formation of a joint black-footed ferret – black-tailed prairie dog Recovery Team in order to facilitate the development of a Recovery Plan.

Since the June 2004 Val Marie workshop (Rodger et al. 2004), a joint Recovery Team has been convened and has had several meetings. The Team decided that the next step in strategy development is to determine quantitative population recovery goals. The group concluded that the best way to proceed with this would be to host a ferret population recovery planning workshop to assist in setting these goals.

To assist in this effort, workshop organizers realized that the Mexican authorities working on ferret recovery in their own country would be valuable through providing expertise and perspective on devising and implementing recovery strategies for ferrets and prairie dogs. The Mexican recovery effort has met many challenges, and the Canadian participants could benefit greatly from their experiences.

To address these concerns, Parks Canada invited the IUCN – Species Survival Commission's Conservation Breeding Specialist Group (CBSG) to design and facilitate a workshop that would bring together experts from across North America to focus on the development of a Canadian species recovery strategy, but to also direct some important attention to the continuation and evolution of recovery efforts in Mexico. CBSG performed a similar type of service for the United States Fish & Wildlife Service in 2003 in Denver, Colorado in order to: 1) identify and explore key questions facing the US Program with regard to recovery of the black-footed ferret; 2) bring all available data to bear on these questions; and 3) determine specific management recommendations based on the results of these deliberations (CBSG, 2004). Canadian and Mexican authorities were interested in extending this analysis to include their particular geographic regions in order to develop effective management goals.

The CBSG Workshop Process

The International Recovery Workshop was held 1 – 4 April, 2005 at the Calgary Zoo, Calgary, Alberta, Canada. Overall objectives for this workshop included:

1) To develop a set of draft population recovery goals as part of a larger Canadian Black-Footed Ferret Recovery Strategy;
2) To identify management and/or research recommendations that can be incorporated into the Strategy;
3) To identify specific management and/or research recommendations that can augment the existing Mexican Recovery Strategy for black-footed ferrets.

Thirty people (18 from Canada, 2 from Mexico, and 10 from the United States) participated in the workshop. The workshop opened with individual participant introductions, and each person was asked to identify what they saw as the primary challenges facing recovery of the black-footed ferret in Canada and Mexico. Almost overwhelmingly, participants identified maintenance of sufficient prairie dog habitat as the primary biological challenge facing ferret recovery across the species' range. Another major challenge identified by many participants is the need for broad acceptance among many stakeholder domains of a dedicated prairie dog habitat management plan. This type of individual issue identification is an important element of the workshop process, designed to demonstrate the convergence of perspectives across multiple levels of experience and involvement with the ferret conservation issue.

Most of the first day was then devoted to a set of presentations by experts in ferret and prairie dog biology and ecology, designed to update all participants on the status of ferret recovery across North America and to enlighten all on the "state of the science" of ferret management – both in captivity and in the wild. The day ended with the identification of four separate topic-based groups that would form the unit of work for the remainder of the workshop. The topics were generated based on congruence among individual statements of challenges to ferret recovery seen earlier in the day, as well as specific discussions with workshop organizers. The four working group topics were:

- Ecology of prairie dogs in Canada
- Population biology and PVA modeling of ferrets in Canada
- Canadian community acceptance and involvement
- Biology and conservation of ferrets and prairie dogs in Mexico

The workshop followed a general format nearly identical to that for the Population and Habitat Viability Assessment process developed by CBSG to assist local governments and other agencies / interested parties in generating action-based strategies for endangered species conservation. The format consists of concurrent and facilitated working-group sessions, separated by periodic plenary sessions designed to inform the groups of each other's progress in the following tasks, specific to the topic designated for each group:

1. Identification and prioritization of problem statements;
2. Assembly and systematic analysis of relevant information;
3. Identification and prioritization of goals;
4. Identification and prioritization of goal-specific action steps.

Throughout the duration of the meeting, the participants engaged in a number of open and productive discussions on the general feasibility of black-footed ferret recovery in Canada. The group was not afraid to ask the most basic of questions: "Is reintroduction of black-footed ferrets into Canada an important component of the overall conservation of the species in North America?" Through intense analysis and deliberation, the group decided by the end of the week that ferret reintroductions in Canada may have a useful role to play in the range-wide conservation of the species, even if the area around Grasslands National Park is on the extreme northern edge of the historic range. This was an important process for the group to work through, and provided the necessary framework for moving forward in conservation planning.

Each working group produces a report of their deliberations, which is included in this draft Workshop Report. The degree of success in a PHVA workshop depends on determining a general outcome where all participants in attendance – many with quite different interests and needs – feel like they have "won" in developing a biologically rigorous demographic simulation model and related management strategy that best represents the reality for the species and is reached by a large degree of consensus. The Workshop Report is developed by the participants themselves and is considered advisory to the relevant management authority for the species. In addition, it is important to recognize that this report does not represent "the final word" on the use of PVA and other methodologies in developing ferret recovery strategies. In fact, our goal is that this workshop and the written results presented here will stimulate the assembly and analysis of many types of new data which will prove critical in the creation of new and refinement of existing management efforts.

Working Group Summaries

<u>Ecology and Management of Prairie Dogs in Canada</u>

The members of this group noted that the existing complex of prairie dog colonies in and around Grasslands National Park is small compared to US and Mexican colonies and relative to the predicted size needed to support a self-sustaining ferret population. In fact, prairie dogs are themselves designated as a species of "special concern" in Canada because of the small size of the species' distribution and population may predispose it to becoming threatened or endangered. Moreover, several other species at risk occur in and near prairie dog colonies and could be affected by a ferret release which must be considered under SARA legislation. The potential release of ferrets in Canada presents some real uncertainties that must be studied as reintroductions proceed.

Based on the identification of these challenges, and a comprehensive assembly of information on prairie dog and ferret biology and conservation, the working group identified as a top-priority goal the establishment of a National Ferret Recovery Strategy for Canada. The Species at Risk Act requires the development of a recovery strategy for black-footed ferrets by June 2007, and a similar plan for black-tailed prairie dogs by June 2008. Along with developing a National Strategy, the group recognized the importance of estimating the effects of ferrets on other Species at Risk in Canada, including prairie dogs, Burrowing Owls and Sage Grouse. Finally, the collection of detailed data on the ecology and demography of black-tailed prairie dogs, as well as for black-footed ferrets, is seen as a vital component of a scientifically sound management Strategy for both species. The group developed a series of detailed action steps designed to achieve these broader management goals.

Population Biology and PVA Modeling of Ferrets in Canada

The population modeling working group was tasked with modeling potential scenarios for the reintroduction and subsequent supplementation of black-footed ferrets to Grasslands National Park (GNP), southern Saskatchewan. The working group intended to adapt an earlier model of black-footed ferret demography in South Dakota's Conata Basin (created at the 2003 CBSG ferret workshop) based on the assumption that it was relevant to the GNP region.

Given the dependence of ferrets on prairie dog populations, some concern arose that the modeling of prairie dog populations in GNP might be more useful for understanding ferret carrying capacity (K) in the Park than would more direct models of ferret populations. Given a lack of readily available data for black-tailed prairie dog/ferret interactions, modeling prairie dog population dynamics in order to derive ferret K would be difficult at this time. The group therefore prioritized the modification of existing Conata Basin ferret models during the course of this workshop. The group developed the GNP model according to estimates of prairie dog density, with reference to ferret data from other reintroduction sites with prairie dog density measures. The group stressed the importance of the future development of a GNP black-tailed prairie dog model and the linking of that model to the GNP black-footed ferret model.

Lengthy discussions ensued on a number of important black-footed ferret biological and ecological parameters: estimating carrying capacity, impacts of inbreeding depression, age-specific mortality rates, effects of plague, and consequences of drought. With the best information available, the group estimated that the GNP habitat could support somewhere between 20 and 50 black-footed ferrets. Subsequent to these discussions, a series of management scenarios were developed that included specific protocols for supplementation of ferrets with or without inbreeding effects or the detrimental impacts of disease or catastrophic drought. Overall, a population of about 50 ferrets has a reasonable level of viability in the long-term, but will likely require continued supplementation of captive stock when population densities dip below a critical level (e.g., 20% of the habitat carrying capacity). These specific management targets can be refined through continued assembly of relevant ecological data on ferrets and prairie dogs from field studies.

Canadian Community Acceptance and Involvement

This group focused on the complexities of achieving sufficient support from local and regional stakeholders and other authorities around the concept of black-footed ferret and black-tailed prairie dog management in southern Saskatchewan. The primary issue facing this group revolved around the likely need to expand the amount of prairie dog habitat suitable for ferret recovery to areas outside Grasslands National Park. This management action could require considerable collaboration with other land managers in the area, including many private landowners. In order to gain their trust and cooperation, prairie dog and ferret biologists would have to develop a rigorous biological and social rationale for the expansion of the black-footed ferret reintroduction area.

Based on a detailed analysis of the relevant information on levels of support for proper ferret management among the many stakeholders in the area, the working group cited as their top priority the importance of gaining greater levels of support for ferret recovery among stakeholders in the core recovery area. This group of stakeholders ranges from ranchers in the immediate area all the way up the chain of authority to regional representatives of agencies such as Parks Canada. The working group suggests the creation and distribution of advanced communication materials, followed by personal meetings with local stakeholders to facilitate the exchange of information and perspectives on the many complicated issues surrounding management of prairie dogs in the context of ferret recovery. The working group did additional work predicated on the assumption that there would be a need to expand black-tailed prairie dog habitat by working with willing partners in the area. Detailed actions describing the accomplishment of these goals are included in the working group report.

Biology and Conservation of Ferrets and Prairie Dogs in Mexico

A smaller number of representatives from Mexico attended this workshop, so we were unable to form more than one topic-based working group specific to the needs of this country's ferret conservation program. Nevertheless, a wide variety of topics were addressed in this group and, through the development of an entirely separate *VORTEX*-based modeling effort, they were successful in setting future directions for the recovery effort in Mexico.

As with the Canadian PVA effort, the Mexico group used the 2003 Conata Basin model as the basis for their own specific work. Through their deliberations, the group recognized that the prairie dog colony size, density, and security may not be sufficient to allow for black-footed ferret population sustainability in the short- and long-term. With this knowledge, the group developed a series of modeling scenarios intended to identify the amount and extent of prairie dog habitat required to support a viable population of ferrets. In addition, they identified the difficulties influencing the lack of success in recent ferret introductions in Chihuahua, and developed goals and actions targeted at addressing these difficulties.

Prioritization of Goal Statements Across Working Groups

In an attempt to develop a meaningful level of consensus among workshop participants on the goals that are important for black-footed ferret recovery in Canada and Mexico, the workshop facilitators led the group through a process whereby the goal statements from all four working groups were prioritized at once by all workshop participants according to a single criterion – defined here as the importance of this goal to the successful recovery of the black-footed ferret in Canada. A separate process using the same criterion was conducted for the goal statements identified by the Mexico group.

The participants of this particular workshop were relatively more homogeneous than in many other CBSG-facilitated PHVA workshops with respect to their position on ferret recovery in Canada and Mexico. Consequently, this group prioritization process is a safe and effective method for achieving a higher level of shared understanding of the issues facing ferret recovery in North America, and for gaining a greater degree of commitment to improve the prospects for successful establishment of the species. If a more diverse group of stakeholders is present in a workshop like this, and in particular those for whom conservation of the species is not of primary concern, then another method of consensus building is required.

Listed below is the prioritized set of goal statements produced by the four working groups, with redundant goals across groups removed where necessary.

Canada

- Develop a black-footed ferret / prairie dog recovery strategy.
- Gain core-area stakeholder support for black-footed ferret recovery.
- Refine evidence-based knowledge of black-footed ferret life history, particularly Canada-specific information. Required information includes: carrying capacity, mortality rates, reproductive rates,

environmental variability in vital rates (including drought and plague), inbreeding effects, and mode of density-dependence.
- Refine evidence-based knowledge of prairie dog life history and develop an appropriate model to study population dynamics.
- Expand the amount of suitable habitat available for black-footed ferrets.
- Understand the impact and interaction of black-footed ferret recovery on other species at risk.
- Gather evidence-based knowledge and develop an appropriate model of ecological community relationships for black-footed ferret communities.
- Assess the risk of disease for associated black-footed ferret and prairie dog populations.
- Gain buy-in from other government agencies (PFRA, SAF, DPAG) to support black-footed ferret recovery.
- Identify, gain understanding, and motivate a subset of adjacent land managers and influential community members that would become supporters of black-footed ferret recovery.
- Promote national and international awareness of black-footed ferret recovery.

Mexico
- Maintain or improve the amount of available black-footed ferret habitat about current (2005) levels.
- Cultivate public and institutional support for maintaining prairie dog habitat and restoring black-footed ferrets.
- Maintain or improve survival rates of released and established black-footed ferret populations.

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Section II
Working Group Report: Ecology and Management of Prairie Dogs in Canada

Working Group Report:
Ecology and Management of Prairie Dogs in Canada

Working Group Participants:
Steve Forrest, World Wildlife Fund
Maria Franke, Toronto Zoo
Keith Gibson, Calgary Zoo
David Gummer, Provincial Museum of Alberta
Geoff Holroyd, Parks Canada
Paul Marinari, US Fish & Wildlife Service
Dave Poll, Parks Canada
Kent Prior, Parks Canada
Robert Sissons, Grasslands National Park
Doug Whiteside, Calgary Zoo

Introduction

Black-tailed Prairie Dogs are restricted in Canada to Grassland National Park and adjacent properties in southern Saskatchewan. Prairie dogs are listed as a species of Special Concern in Canada because the small geographic distribution, isolation, and population size of the Canadian prairie dog population increase the risk of the species becoming threatened or endangered in Canada (Gummer 1999). Black-footed ferrets are officially extirpated in Canada. Historical specimens and recent unconfirmed sightings extend outside the range of Black-tailed Prairie Dogs (Laing and Holroyd 1989). While ferrets are considered obligate prairie dog predators, the possibility of ferrets surviving on Richardson's ground squirrels – which occur throughout the historic range of ferrets – should be considered (Laing and Holroyd 1989).

Plague, which has dramatically impacted prairie dogs in the US, has not been documented in colonies in Canada. However antibodies for plague have been documented in domestic carnivores near the park and more extensively in southern Saskatchewan (Leighton et al. 2001).

Other species that are listed as endangered, threatened and special concern are associated with prairie dog colonies. Under Canadian federal Species at Risk Act (SARA) legislation, the impact of any activity on the residence or habitat of a listed species must be considered prior to the action for migratory birds and other listed species on federal land. In addition, the impact of a ferret release on other potential prey should not result in declines of the prey species.

In 2004, after the workshop in Val Marie, a new recovery team was created for both prairie dogs and ferrets, with co-chairs identified for each species.

General Problem Statements

The presence of black-tailed prairie dogs on secure federal land, adjacent private land and privately leased crown land provides an opportunity to consider the release of black-footed ferrets on this complex of prairie dog towns. In addition, successful captive breeding in the US and Toronto will soon result in more ferrets available for release than are needed for releases in the US and Mexico. Considerable experience and information has been gained through the releases in the US and Mexico in the past 15 years.

We identified three primary challenges affecting the reintroduction of black-footed ferrets into Canada:

1. The existing complex of prairie dog colonies is relatively small compared to US and Mexican colonies and to the predicted size needed to support a self-sustaining ferret population.
2. Several species at risk, in addition to prairie dogs, occur in and near prairie dog colonies and could be affected by ferret releases.
3. The release of ferrets in Canada presents many uncertainties that must be estimated or studied as a release progresses.

Information Assembly and Analysis

Black-tailed prairie dog issues

The carrying capacity of the prairie dog colonies to support ferrets is not known. The area of the 23 Canadian prairie dog colonies has been measured over the past decade (Figure 1; Table 1). The density of prairie dogs has also been estimated at the 23 colonies. Population dynamics of prairie dogs are not known, especially at this northern edge of the species' range. As prairie dog populations may need to be increased to support black-footed ferrets, an understanding of the factors limiting prairie dog is needed.

Prairie dog numbers and colony size seem to have declined after dry periods in the summer of the year prior to the surveys. Frequency and severity of drought needs to be determined from weather records.

In addition to being a species of "Special Concern" under the Canadian Species At Risk Act, prairie dogs are protected from unlicensed shooting under provincial legislation. Legally, they cannot be poisoned, and can only be shot by local landowners if they have been issued a permit from the provincial government. This protection should reduce the risk of human-caused catastrophes. Human harassment results in lower body weights in some colonies in the U.S. Thus in the Canadian colonies prairie dogs maybe heavier which may benefit productivity and survival.

All the existing US data shows that prairie dogs are the primary food of ferrets. The availability of ground squirrels is unknown. The mean mass of Richardson's ground squirrels is approximately 1/3 to 1/2 of black-tailed prairie dogs (Michener and Koeppl 1985), and larger than ground squirrels species that occur elsewhere in the range of ferrets. The possibility exists that Richardson's ground squirrels could be important prey for ferrets but was not included in the analysis. We recommend that any releases be based on the known association between black-footed ferrets and Richardson's ground squirrels, and then, the diet of released ferrets in the presence of ground squirrels be determined.

Available information on ground squirrels should be compiled and surveys for ground squirrels in prairie dog colonies conducted.

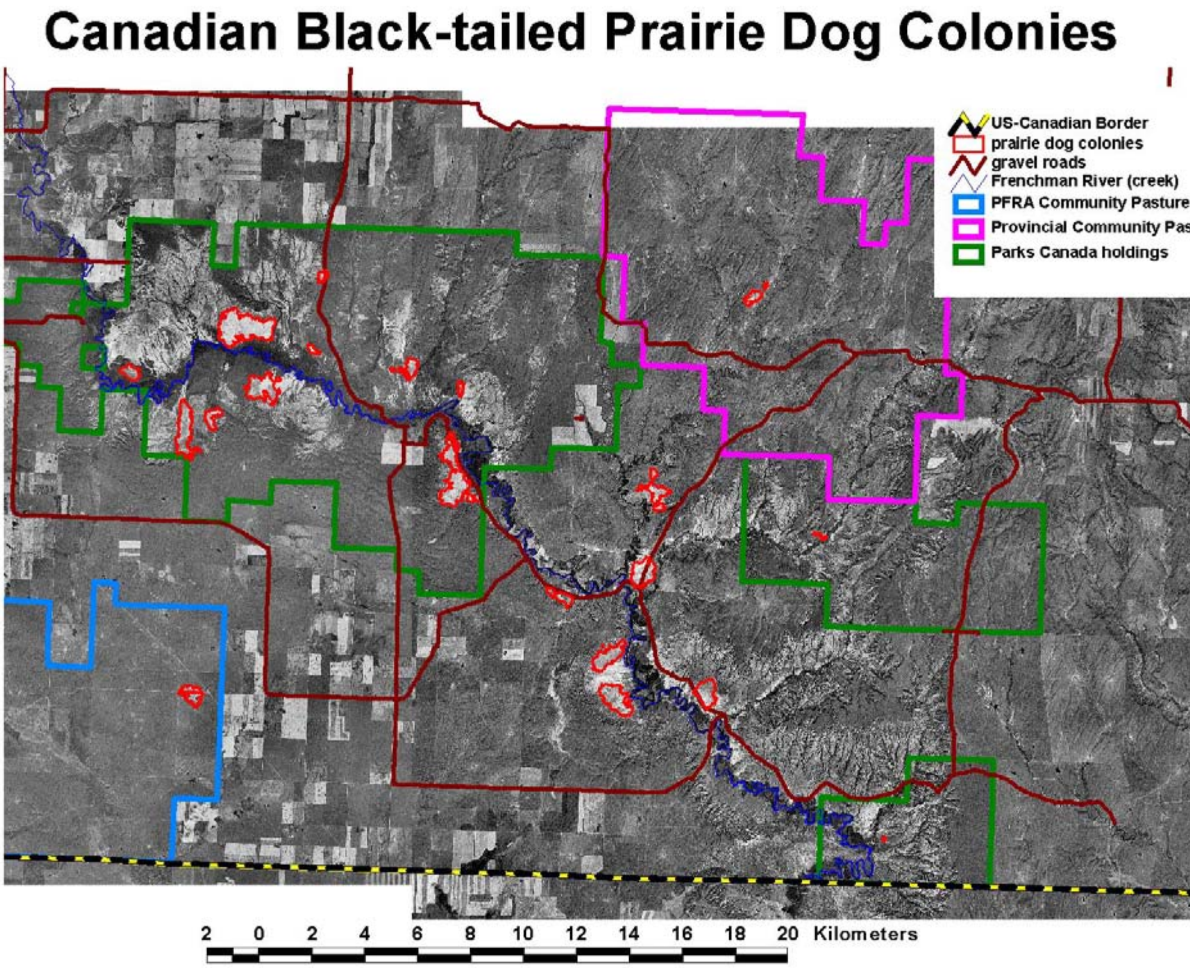


Figure 1. Black-tailed prairie dog colonies in Canada.

Table 1. Names and size (ha) of black-tailed prairie dog colonies in and around Grasslands National Park of Canada (1993-2004). Blank areas in the table indicate that the colony was not surveyed during that year.

Colony	Name	19931	19942	1995-963	19964	19975	19986,7	20008	% Change10 (1996/7/8 to 2000)	2002	% Change11 (2000 to 2002)	2004	% Change11 (2002 to 2004)	% Change 1998-2004
1	Laovenan (Ecotour)	3.15		2.68			5.94	7.49	+26.09%	10.98	+46.60%	13.02	18.58	119.19
2	Snake Pit	163.59		164.96			171.56	190.51	+11.05%	187.58	-1.54%	173.3	-7.61	1.01
3	70 Mile Butte	24.49		28.24			26.13	27.01	+3.37%	27.89	+3.26%	16.76	-39.91	-35.86
4	Monument West	72.21		72.33			76.81	84.78	+10.38%	91.84	+8.33%	81.757	-10.98	6.44
5	Monument East	13.75		17.39			21.11	23.56	+11.61%	27.00	+14.60%	26.58	-1.56	25.91
6	Monument Southeast							0.87	N/A	1.87	+114.94%	1.96	4.81	125.29
7	Broken Hills	95.23		81.60			94.07	94.10	+0.03%	85.58	-9.04%	77.624	-9.30	-17.48
8	Sage	2.87		6.05			8.32	6.83	-17.91%	8.27	+21.08%	8.19	-0.97	-1.56
9	Police West	0.09		0.43			1.30	0.85	-35.62%	1.51	+77.65%	2.221	47.09	70.85
10a	Police Main (East)	13.95		17.29			23.02	22.40	-2.69%	22.93	+2.37%	19.651	-14.30	-14.64
10b	Police Central						0.79	0.68	-13.93%	1.66	+144.12%	3.621	118.13	358.35
10c	Police Southeast						2.94	2.47	-15.99	3.18	+28.74%	3.049	-4.12	3.71
11	Timbergulch	2.19		4.80			7.81	7.15	-8.46%	8.50	+18.88%	7.41	-12.82	-5.12
12	Larson	110.35		132.89			157.04	147.09	-6.34%	146.68	-0.28%	147.23	0.37	-6.25
13	North Gillespie	15.50		19.10			9.73	1.66	-82.94%	3.35	+101.81%	4.137	23.49	-57.48
14	South Gillespie			0.21			0.55	0.77	+40.00%	1.17	+51.95%	1.68	43.59	205.45
15	Masefield9	27.62		31.38			34.25	38.76	+13.17%	37.09	-4.31%	39.653	6.91	15.78
16	Dixon Hill				6.51	9.15		8.04	-12.14%	8.34	+3.37%	10.24	22.78	11.91
17	Dixon North				51.26	57.56		50.61	-12.07%	45.54	-10.02%	45.19	-0.77	-21.49
18	Dixon Main		57.27		58.71			68.70	+17.02%	70.734	+2.96%	66.82	-5.53	13.81
19a	Dixon West		3.97											
19	Dixon West		16.70		23.30	26.35		26.58	+0.87%	27.26	+2.56%	22.98	-15.70	-12.79

20	Dixon Southwest		75.79	64.13	72.24		67.14	-7.07%	65.94	+1.79%	61.82	-6.25	-14.42
21	Dixon South		82.42	81.05	80.97		91.59	+13.12%	85.99	-6.11%	69.25	-19.47	-14.47
22	Walker		57.69	60.76			51.20	-15.73%	-11	-11	-11	-11	
23a	Dixon Pasture "A"	2.56											
23b	Dixon Pasture "B"	2.51											
23c	Dixon Pasture "C"	1.57											
23d	Dixon Community Pasture South					20.96	23.29	+11.12%	20.19	-13.31%	6.1	-69.79	-70.90
23e	Dixon Community Pasture North					2.82	3.67	+30.14%	2.37	-35.42%	3.05	28.69	8.16
Sub-total	**Park Colonies**					607.12	618.22	1.83	629.99	1.90	588.19	-6.64	-3.12
Sub-total	**Other Colonies**					423.77	429.58	1.37	363.45	-15.39	325.10	-10.55	-23.28
Total Area	**All colonies**					1030.89	1047.80	1.64	1044.64	-0.30	964.49	-7.67	-6.44

1 Gauthier and Boon (1994)
2 Saskatchewan Environment and Resource Management (SERM) survey
3 Grasslands National Park (GNP) survey
4 Dixon West (21a and 21) merged into one colony. SERM survey
5 SERM survey
6,8 Joint GNP/SERM survey
7 Dixon Pastures "B" and "C" merged to become Dixon Community Pasture South; Dixon Pasture "A" is Dixon Community Pasture North
9 Masefield data was initially calculated as 36.62 ha in 1998. The data was re-calculated and 1.98 ha was deducted for the dugout tand 0.39 ha for the road. This re-calculation gives a 1998 total of 34.25 ha. This increases the 1998-2000 expansion rate from +5.84% (using 36.62 ha for 1998) to +13.17% (using 34.25 ha for 1998).
10 Percentage change calculated on 2000 survey and last previous survey for the specific colony in question. The total cumulative prairie dog colony area for the 1996/7/8 period used for the % change calculation was 1030.89 ha. The 1996/7/8 areas used for the % change calculation are marked with a yellow highlight.
11 No data was collected for the Walker Prairie Dog Colony in the year 2002 and 2004
12 The total area of all colonies for the year 2002 and 2004 was calculated using the year 2000 values from the Walker colony.

Other species issues

How might the release of ferrets affect other potential prey species, their residences and their habitats in and near prairie dog colonies?

Aside from prairie dogs, other species that are potential prey for ferrets and are listed by COSEWIC include Burrowing Owls, Sage Grouse, leopard frog, etc. The Grassland complex of prairie dog colonies supports the densest population of burrowing owls in Canada. The number of pairs of owls has increased from xx pairs in 1999 to 48 pairs in 2004. The intensity of any ferret predation on burrowing owls is unknown. No prairie dog colony has been more important than any other in the past 7 years. In addition, stable isotope analysis has shown that the 'population' of burrowing owls Canada is comprised of about 55% owls that were raised or bred in the US and Mexico the previous year, i.e. immigration of owls is about 55% per year. Thus, any ferret predation on owls may affect nest success and productivity that year, but is unlikely to affect owl population in subsequent years. GNP owls may also serve as a source population for Burrowing Owls in other areas of the Great Plains. If prairie dog management to support ferret releases results in the expansion of prairie dog colonies, then that should benefit Burrowing Owls. However, if ferret reintroductions were to be associated with declines in prairie dogs, through interactions with disease risk, climate, extreme weather, or other factors, then that could cause declines in burrowing owls.

Ferrets might be a predator on sage grouse nests, but are not likely a major predator on sage grouse. The overall impact of ferret release on sage grouse is likely to be minimal. The expansion of prairie dogs into sage habitats could have a greater effect on sage grouse. However, prairie dogs could be 'directed' away from sage habitats and into grassland areas that are not prime habitats of sage grouse. Any new prairie dog colonies can be directed into areas not occupied by sage grouse.

Ferrets are not likely to have any effect on short-horned lizards, racer, and leopard frogs, or their habitats.

How might prairie dogs be affect by the additional predation pressure by ferrets in addition to existing predation by badgers, swift fox, red fox, coyote, bobcats, golden eagles, ferruginous hawks and other predators?

The northernmost population of prairie dogs appears to be unique among black-tailed prairie dogs in that they hibernate for up to 100 days per year (Gummer 2005). The implications of releasing ferrets, a specialized predator that takes prairie dogs in their underground burrows, on winter behaviour and population dynamics of northern prairie dogs are uncertain. It is unlikely that ferrets would directly cause significant declines in prairie dog numbers, though ferret predation may interact with other factors such as disease, climate, or extreme weather, to potentially cause declines in prairie dogs and size of prairie dog colonies. Monitoring and research will be needed to evaluate these factors and interactions at the northern peripheries of the species ranges.

The numbers of raptors in around GNP are known (Sissons and Holroyd) and are low. One breeding pair of golden eagles occurs in the park, and several pair of ferruginous hawks nest in the surrounding lands. Coyote numbers are unknown but probably moderate (Sissons). Badgers are seen regularly in the colonies but would be at low density (Holroyd). Raccoons are in the region but believed to be at low densities in the colonies (Sissons and Holroyd). No feral dogs or cats are known to inhabit the park, although pet dogs occasionally are seen off-leash in the park (Sissons).

Black-footed ferret management scenarios

What species might be vectors of disease in the colonies?

Plague antibodies have been detected in the region in domestic dogs and cats. Serological prevalence of plague was 4.2%, about 1/3 of levels found in the US (Leighton 2001) Tularemia prevalence was 9.2%.

How will the ferret reintroduction proceed under various management scenarios?
Genetic considerations are determined through the captive breeding program and as diverse a founder population as possible would be provided in the USF&W allocation.

When and how often will supplementation of ferrets be necessary?
Since the Canadian ferret population will be small, supplementation maybe necessary following stochastic catastrophes. *VORTEX*-based scenarios will predict the need for ferrets, and updated based on ferret survey results after releases.

Harvest
Harvest maybe possible if the ferret population expands to the limits of the prairie dog populations. The use of any harvest ferrets will be constrained by cross-border issues, permits, disease concerns, and need. Quarantine facilities are available in Calgary if needed.

Funding for ferret reintroduction and prairie dog management
We assume that in the short term funding will be available from SARA funding through Parks Canada. The security of longer term funding is unknown and will depend upon the program's success and need as well as other priorities within GNP. The recovery team will have to be active to ensure continuous funding is available.

Disease surveillance – What are the causes of death of ferrets and prairie dogs?
Monitoring of serological prevalence of plague and tularemia in associated carnivores should be undertake regularly (annually is recommended in US). This monitoring could be conducted through local coyote harvests in winter. Monitoring of other mortality factors such as predation and over winter mortality is also beneficial.

Infrastructure for ferret reintroduction

Table 2 below summarizes the available information discussed by this working group.

Table 2. Summary of information on black-tailed prairie dog and black-footed ferret biology and ecology relevant to the discussion of ferret recovery in southern Saskatchewan. See text for accompanying information.

Parameter	Priority	Fact / Assumption	Specific Data	Source*	Comments
Carrying Capacity					
Prairie dogs					
Density, Dixon Ranch	1	A		PC	Visual counts; actual density = SD
Density, Larson Ranch	1	A		PC	Visual counts; actual density = SD
Average colony area, Dixon	2	F; 2004	46.8 ha	PC, SE	
Average colony area, Larson	2	F; 2004	41.6 ha	PC, SE	
Colony area, Dixon	2	F; 2004	327.5 ha	PC, SE	
Colony area, Larson	2	F; 2004	582 ha	PC, SE	
Colony area, TOTAL	2	F; 2004	964.5 ha	PC, SE	
Age at breeding	3	F	21 months	Hoogland, 1995	Small % breed as yearling, then majority at 2 yrs of age (also Gummer 1999 and unpubl. data for GNP)
Breeding season	3	F	Early March	Hoogland, 1995	(also Gummer 1999 and unpubl. data for GNP)
First-year mortality	3	F	0-1:54%(♀), 47%(♂)	Hoogland, 1995	
Gestation	3	F	35 days	Hoogland, 1995	
Litter size	3	F	1 – 8 pups	Lab studies	(also Gummer 1999 and unpubl. data for GNP)
Litter size, first emergence	3	F	2.3 – 5.5 pups	Millson, 1976	Saskatchewan (also Gummer 1999 and unpubl. data for GNP)
Longevity, years	3	F	8 (♀), 5 (♂), maximum	Hoogland, 1995	
Reproductive frequency	3	F	Annually	Hoogland, 1995	(also Gummer 1999 and unpubl. data for GNP)
Survivorship	3	F	44% (dispersers), 91% (sedentary)	Hoogland, 1995	(also Gummer 1999 and unpubl. data for GNP)
Hibernation	3	F; 1997 – 2002	Nov – Mar (100 days)	Gummer, 1999 and unpubl. data	Hibernate in groups
Weaning	3	F	41 days	Hoogland, 1995	
Body mass	3	F	> s conspecifics	Gummer, pers. comm.	
Juvenile body mass (late summer)	3	F	750g (August)	Gummer, 1999 and unpubl. data	More than SD, but low N
Drought frequency	4	F, A			

Drought impact on density, colony size	4	A; 2 years of counts 1996 – 2004	Low	PC, limited data	
Colony number, Larson	5	F; 2004	14	PC, SE	
Colony number, Dixon	5	F; 2004	7	PC, SE	
Colony number, TOTAL	5	F; 2004	26	PC, SE	
Burrow microclimate	6	F; 1997 – 2002	33 - 40°F (<10°C)	Gummer 2005 and unpubl. data	Considerable differences among sites and among years
<u>Ground squirrel</u>					
Density and distribution	7	F			
Emergence	8	F	Feb (♂); March (♀)	G. Michener (U. Lethbridge)	
Hibernation	8	F	Sept/Oct (J♂); Aug (J♀); July (♂); Aug (♀)	G. Michener (U. Lethbridge)	
Impact on Other Species					
Carnivore sampling sylvatic plague	1	F, A	Sero-positive	CCWHC, US	Rural dogs and cats; vacc. program
Carnivore sampling canine distemper	2	A	Sero-positive	D. Whiteside	Rural dogs and cats, vacc program
Impact on Burrowing Owls	3	A	Minimal	Duxbury Holroyd, pers. comm.	High dispersal
Impact of BFF release on Sage Grouse	3	A	Minimal	Rob, pers. comm.	
Impact on all other prairie spp.	3	A	Minimal	Group	
Impact of PD expansion	4	A	Minimal with mgmt.	Rob, pers. comm.	Possible benefit for dancing
BFF Management Scenarios					
Harvest of animals	1	A	Required based on K	Group	Disease, quarantine, border issues
Supplementation of population	1	A	Required based on small pop. Density	Group	Depending on SSP production
Monitoring	2	F, A			Base on US recovery sites
Political issues (SARA)	2	U		SARA	Species at Risk Act
Disease surveillance	3	F, A			Opportunistic
Funding for BFF Recovery and PD Mgmt.	4	F, A	High (short-term); Unknown (long-term)		Pre-success high; post-success moderate
BFF availability	5	F, A	High	Marinari, pers. comm.	Depending on SSP production
BFF genetic considerations	5	F	Addressed in FWS allocation	Marinari, pers. comm.	Representative animals will be provided
Coyote density	6	A	Moderate	Rob, pers. comm..	Disease concern

Badger density	7	A	Low	Rob, pers. comm.	
Domestic pets	7	A	Low	Rob, pers. comm.	Visitors' dogs
Raccoons	7	A	Low	Rob, pers. comm.	Disease concern
Raptor density	7	A	Low	Rob & Geoff, pers. comm.	
BFF Recovery infrastructure	8	F, A			CBFFBTPDRC
Organizational issues	8	U		Park Mgmt. Plan, NPA	Change in mgmt. of stakeholders
BFF border, Canada to US	9	A		Group	Permits, border, politics, quarantine
BFF border, US to Canada	9	A		Group	Permits
BFF demography	10	F		US	Make sure data are in model!

* PC = Parks Canada
US = United States
CCWHC = Canadian Cooperative Wildlife Health Center
CBFFBTPDRT = Canada Black-footed Ferret and Black-tailed Prairie Dog Recovery Team

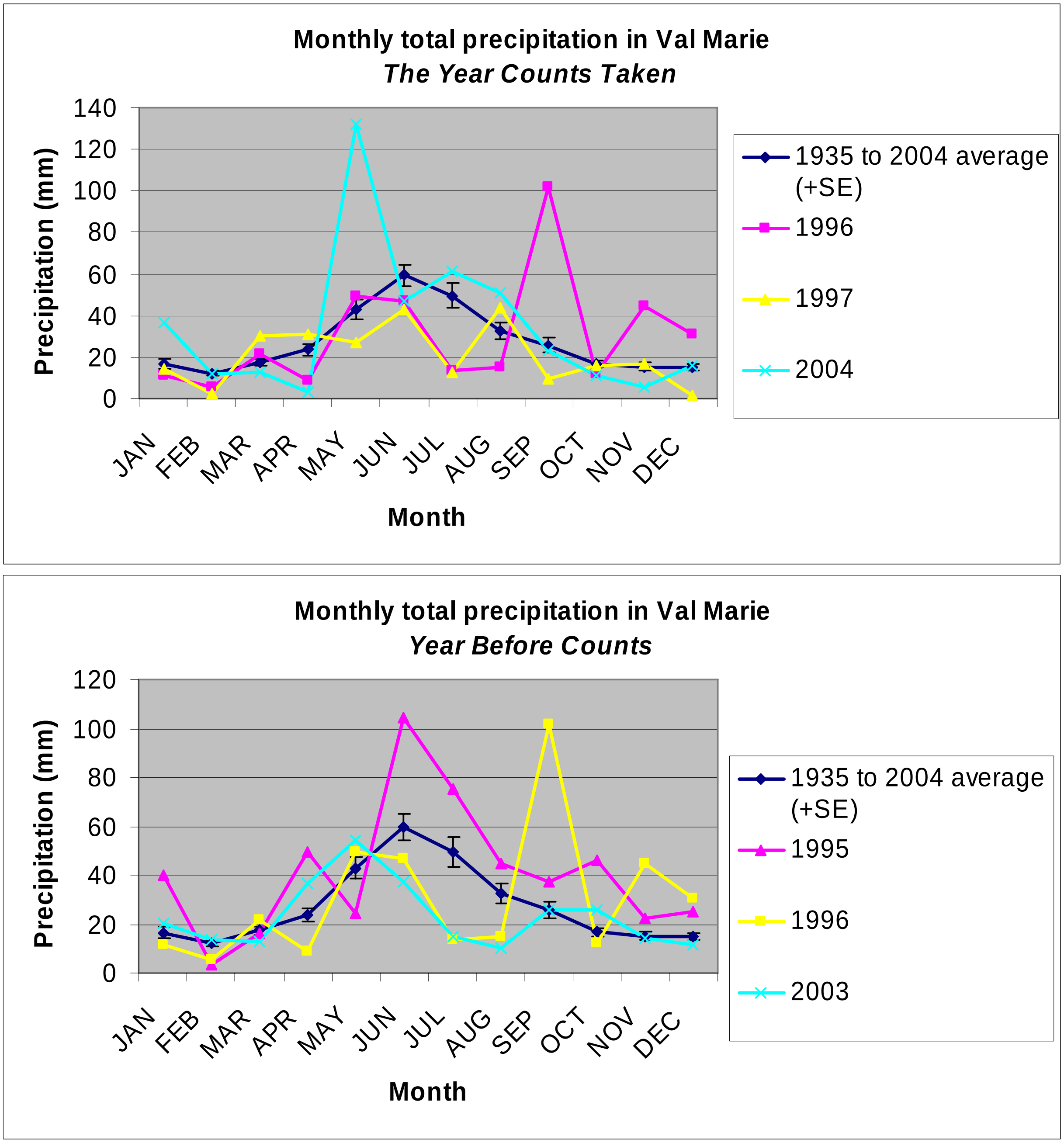
Table 3. Prairie dog maximum count data, 1996 – 2004. Density calculation based on counting area of 4ha. [Dens*] is predicted density based on Sevensen and Plumb (1998): Dens* = (Dens/0.4) – 3.04. Note that 2004 counting areas do not line up with those from 1996 – 1998. Sage colony counts are not included here since counting area was less than 4ha. See text for accompanying information.

	2004			1998			1997			1996		
Colony	**Max**	**Dens**	**Dens***	**Max**	**Dens**	**Dens***	**Max**	**Dens**	**Dens***	**Max**	**Dens**	**Dens***
Broke Hill N				99	24.75	58.84	69	17.25	40.09			
Broke Hill S				66	16.5	38.21	36	9.0	19.46			
Larson N	23	5.75	11.34	50	12.5	28.21	72	18.0	41.96			
Larson S	20	5.0	9.46	34	8.5	18.21	48	12.0	26.96			
Larson	43	10.75	23.84									
Mile 70				46	11.5	25.71	51	12.75	28.84	63	15.75	36.34
Monument A				88	22	51.96	55	13.75	31.34	78	19.5	45.71
Police Coule				68	17	39.46	87	21.75	51.34	109	27.25	65.09
Snake Pit E	19	4.75	8.84	77	19.25	45.09	71	17.75	41.34	96	24	56.96
Snake Pit NW	22	5.5	10.71	63	15.75	36.34	49	12.25	27.54	95	23.75	56.34
Snake Pit SW	20	5.0	9.46	28	7	14.46	22	5.50	10.71	41	10.25	22.59
Mean		6.13	12.27		15.48	35.65		14.00	31.96		20.08	47.17
SD		2.30	5.74		5.69	14.23		4.79	11.98		6.26	15.65

Table 4. Annual rainfall (mm) during the summer months around Val Marie, Saskatchewan, from 1953 to 2004. Note data gaps in 1961 and 1964-1966. Data in bold indicates "bad" years, while underlined data indicates "poor" years. Mean across years: 181.5mm (SD = 76.78).

Year	May	June	July	August	TOTAL
1953	111.4	74.6	31.2	10.2	227.4
1954	46.3	95.5	27.2	103.5	272.5
1955	52.7	11.2	177.0	5.1	246.0
1956	47.6	64.5	37.0	26.0	175.1
1957	**9.4**	**32.6**	**2..8**	**37.3**	**103.1**
1958	**5.1**	**24.3**	**22.2**	**26.4**	**78.0**
<u>1959</u>	<u>13.0</u>	<u>85.7</u>	<u>6.3</u>	<u>18.3</u>	<u>123.3</u>
1960	**19.3**	**18.0**	**3.8**	**33.1**	**74.2**
1962	34.2	61.9	156.9	32.5	285.5
<u>1963</u>	<u>3.3</u>	<u>48.5</u>	<u>36.4</u>	<u>36.9</u>	<u>125.1</u>
1967	**16.9**	**29.1**	**5.4**	**5.1**	**56.5**
1968	**19.1**	**31.4**	**6.6**	**53.9**	**111.0**
<u>1969</u>	<u>17.5</u>	<u>64.3</u>	<u>58.4</u>	<u>2.5</u>	<u>142.7</u>
1970	10.2	111.1	43.8	5.5	170.6
1971	**18.3**	**31.6**	**39.7**	**5.1**	**94.7**
<u>1972</u>	<u>47.0</u>	<u>41.0</u>	<u>28.4</u>	<u>7.1</u>	<u>123.5</u>
1973	21.6	38.4	12.3	78.3	150.6
1974	115.1	5.9	42.4	73.2	236.6
1975	85.7	58.9	35.9	79.9	260.4
1976	14.5	91.5	22.7	45.6	174.3
1977	58.2	33.5	42.5	20.0	154.2
1978	53.0	68.7	75.1	29.8	226.6
1979	39.6	39.0	78.4	15.2	172.2
<u>1980</u>	<u>26.0</u>	<u>82.8</u>	<u>16.2</u>	<u>23.0</u>	<u>148.0</u>
1981	54.6	71.9	30.0	2.0	1158.5
1982	87.7	35.4	99.4	8.4	230.9
<u>1983</u>	<u>57.0</u>	<u>18.2</u>	<u>44.6</u>	<u>7.2</u>	<u>127.0</u>
1984	**24.8**	**46.6**	**4.0**	**14.0**	**89.4**
1985	**58.6**	**7.0**	**0.6**	**40.4**	**106.6**
1986	96.2	56.2	19.8	6.4	178.6
1987	46.8	38.8	79.2	22.8	187.6
<u>1988</u>	<u>6.4</u>	<u>71.0</u>	<u>55.8</u>	<u>4.2</u>	<u>137.4</u>
1989	64.2	87.8	67.0	65.0	284.0
1990	65.2	45.0	98.2	27.2	235.6
1991	60.0	208.8	44.0	42.0	354.8
1992	17.6	96.4	78.4	57.0	249.4
1993	5.2	83.0	171.6	113.2	373.0
1994	61.4	97.0	17.0	20.0	195.4
1995	24.2	104.2	75.0	45.0	248.4
<u>1996</u>	<u>49.6</u>	<u>46.6</u>	<u>13.4</u>	<u>14.8</u>	<u>124.4</u>
<u>1997</u>	<u>27.4</u>	<u>42.8</u>	<u>12.8</u>	<u>43.4</u>	<u>126.4</u>
1998	12.1	96.2	48.0	31.8	188.11
1999	70.4	38.6	64.6	22.8	196.4
2000	64.5	43.8	88.8	29.8	226.9
2001	21.2	49.6	88.0	0.4	159.2
2002	10.8	141.2	70.6	101.8	324.4
2003	**54.2**	**37.0**	**15.0**	**10.2**	**116.4**
2004	132.4	47.2	61.2	51.2	292.0

Figure 2. Monthly precipitation totals in Val Marie, Saskatchewan during years of prairie dog census counts (upper panel) and the year before such counts were taken See accompanying text for additional information.



Goals and Actions

Based on the identification of issues pertaining to black-footed ferret and black-tailed prairie dog management, as well as after the assembly and analysis of the pertinent information available to those at the workshop, this working group has identified a series of goals and actions that are designed to directly address the issues identified above.

Goal

Develop Canadian Black-footed Ferret Recovery Strategy. SARA requires the development of a recovery strategy for black-footed ferret by June 2007, and a management plan for black-tailed prairie dog by June 2008. Action plans for these species need to be developed at a subsequent date. The ferret plans should not be developed in isolation from the international efforts to reestablish this species in North America.

Actions

1. Determine the management scenarios for black-footed ferret reintroduction in Canada.
   Responsible Parties: Recovery Team
   Timeline: Ongoing
   Collaborators / Resources: USFWS, other ferret release plans, SSP, CS
   Costs: About $10,000
   Consequences:
   Obstacles:

2. Contract ecological review of black-footed ferret to summarize the background life history of ferrets in US.
   Responsible Parties: Craig Knowles
   Timeline: Draft document completed
   Collaborators / Resources:
   Costs: $5,000
   Consequences:
   Obstacles:

3. Integrate Canadian Recovery with US and Mexico efforts. Integrate the ferret reintroduction into efforts to maintain sustainable populations in North American. The population in Saskatchewan may not be sustainable. However, the Saskatchewan release may contribute to recovery of ferrets in NA. Thus sustainability in Canada should not be the only goal of the Canadian effort. The Canadian release can contribute to tri-national efforts through maintenance of genetics; learn about the ecology of ferrets at the northern edge of their historic range, comparative studies with more southerly populations, etc.
   Responsible Parties: Pat Fargey, Mike Lockhart, Rurik List
   Timeline: Ongoing
   Collaborators / Resources: All BFF-related plans, etc.
   Costs: $10,000
   Consequences: Increased communication
   Obstacles: Potential political conflict

4. Draft a complete Recovery Strategy as required by SARA.
   Responsible Parties: Recovery Team
   Timeline: Fall 2005
   Collaborators / Resources: USFWS, other ferret release plans, SSP, CS
   Costs: $5,000
   Consequences: One step closer to release; completion of legal requirement

Obstacles: Politics, time constraints

5. Conduct community consultation on the draft strategy as required by SARA. The amount and form of consultation is unknown but will include local landowners and land managers.
   Responsible Parties: Recovery Team
   Timeline: ASAP
   Collaborators / Resources: Parks Canada, Environment Canada
   Costs: $5,000
   Consequences: Completion of legal requirement; ensure buy-in by stakeholders, agencies, and the community
   Obstacles: No buy-in ; political issues

6. Prepare a Communications Plan for Black-footed Ferret that is coordinated with the international ferret committee and their communications plan. A communications plan was drafted in April 2005 and is available for comment by the team.
   NOTE: The Draft Communications Plan for the black-footed ferret is included in Appendix 1 of this workshop report.
   Responsible Parties: Maria Franke, Geoff Holroyd
   Timeline: Draft completed
   Collaborators / Resources: Recovery Team
   Costs: >$10,000
   Consequences: Unified Recovery Team message
   Obstacles: Stakeholder reluctant to accept document (doesn't represent their concerns)

7. Use the 1992 Black-footed Ferret Recovery Plan, the June 2004 Workshop and the April 2005 Workshop proceedings to develop a draft recovery strategy. These three documents and the US recovery plans will provide the basis of a new Canadian recovery strategy.
   Responsible Parties: Pat Fargey, Maria Franke
   Timeline: ASAP
   Collaborators / Resources: USFWS, CS
   Costs:
   Consequences: Better-informed, increased knowledge of Recovery Team
   Obstacles:

8. Submit a request for ferrets to USFWS to be inserted into the allocation matrix that's used to allocate black-footed ferrets to reintroduction sites. Each spring the USFWS assesses request for ferrets for autumn releases. A Canadian request should be submitted in the spring of 2006, if an autumn release is to be implemented.
   Responsible Parties: Pat Fargey, Recovery Team
   Timeline: Mid-March 2006
   Collaborators / Resources: USFWS
   Costs:
   Consequences: Allocated ferrets for release
   Obstacles: Consensus on release strategy, SSP production

9. Establish appropriate contacts with US led black-footed ferret recovery committees. The US-Mexico releases are conducted under the direction of an executive committee and sub-committees. This Canadian release will be coordinated through these committees and Canadian representatives will be expected to participate in the international coordination.
   Responsible Parties: Recovery Team
   Timeline: Fall 2005
   Collaborators / Resources: ROMAN
   Costs: $10,000

Consequences: Approval of Recovery Strategy
Obstacles: Political issues; time constraints

10. Ensure diverse genetics in founder population through the request to the SSP for ferrets.
Responsible Parties: Maria Franke
Timeline: Fall 2005
Collaborators / Resources: SSP, SPMAG, Canadian Recovery Team, USFWS
Costs: None
Consequences: Maximize genetic diversity of released ferrets
Obstacles: SSP production and demographic & genetic structure of captive population

11. Conduct ferret surveys using the US survey protocol 30 days post release and semi-annually in the year post-release.
Responsible Parties: Parks Canada
Timeline: Ongoing post-release
Collaborators / Resources: Existing ferret monitoring programs; Prairie Wildlife Research; USFWS; USGS; Canadian Recovery Team
Costs: >$10,000
Consequences: Generation of a monitoring protocol
Obstacles: Logistics, cost

12. Develop and prioritize research needs for both ferrets and prairie dogs in release area.
Responsible Parties: Recovery Team
Timeline: Fall 2005
Collaborators / Resources: USFWS; CS; universities; Prairie Wildlife Research; researchers; zoo community
Costs: Minimal
Consequences: Better understanding of what needs to be done
Obstacles: Time; engagement of researchers

13. Develop monitoring plan for black-tailed prairie dogs in release area.
Responsible Parties: Parks Canada
Timeline: Ongoing pre- and post-release of ferrets
Collaborators / Resources: USGS; USFWS; researchers
Costs: >$10,000
Consequences: Generation of a monitoring protocol
Obstacles: Logistics, cost

14. Conduct a meta-analysis of previous reintroductions.
Responsible Parties: Recovery Team
Timeline: Ongoing
Collaborators / Resources: USGS; USFWS; researchers; BFF Symposium proceedings; all previous reintroductions
Costs: >$10,000
Consequences: Better understanding of ferret reintroduction protocols
Obstacles: Complexity of gathering all information (no summarized results currently exist)

15. Develop document detailing logistics of ferret release program.
Responsible Parties: Canada Recovery Team; USFWS
Timeline: Mid-March 2006
Collaborators / Resources: USFWS; zoo community
Costs: $10,000
Consequences: Minimize complications of getting ferrets on the ground
Obstacles: Obtaining permits; political issues

Goal

Improve understanding of black-tailed prairie dog density and distribution. Current estimates of black-tailed prairie dog are based on small sample sizes and on one of the US protocols for field sampling. Prairie dogs in Saskatchewan have extreme conditions, hibernate, and weigh more than southern populations. Little is known about most demographic parameters in this northern population. This information is needed to better determine the carrying capacity of colonies to support ferrets.

Actions

1. Improve and update our knowledge of black-tailed prairie dog demography, density and distribution in Canada at the northern edge of their range.
   Responsible Parties: Parks Canada and researchers
   Timeline: Ongoing pre- and post-release
   Collaborators / Resources: USGS, US land management agencies, US BTPD management groups and plans, Predator Alliance, Parks Canada, Saskatchewan Environment
   Costs: >$10,000
   Consequences: Better understanding of ferret carrying capacity; greater knowledge of prairie dog system
   Obstacles: Cost, timeframes, stakeholder access, standardization of protocols

2. Improve knowledge of climate on black-footed ferret prey species and predator/prey relationships. Drought reduces carrying capacity of the area through reduced numbers of prairie dogs. The frequency and severity of drought varies. The pattern of past droughts can be used to predict potential effects of weather events and climate on black-tailed prairie dog and black-footed ferret.
   Responsible Parties: Parks Canada and researchers
   Timeline: Ongoing pre- and post-release
   Collaborators / Resources: USGS, US land management agencies, US BTPD management groups and plans, Predator Alliance, Parks Canada, Saskatchewan Environment
   Costs: >$10,000
   Consequences: Better understanding of ferret carrying capacity; greater knowledge of prairie dog system
   Obstacles: Cost, timeframes, stakeholder access, standardization of protocols

3. Improve sampling protocols and correction factors to determine black-tailed prairie dog densities. Current correction factors for visual counts are taken from US studies. These have low precision for predicting prairie dog numbers and the correction factors may not be appropriate for the Canadian prairie dog populations. Mexican researchers have moved to a triangular sampling protocol with appears more efficient that the square sampling protocol that is currently used in the US. Sampling protocols need to be compared for accuracy and efficiency. In addition, it may be more economic to estimate population size through other means, such as genetic analysis of black-tailed prairie dog pellets.
   Responsible Parties: Parks Canada and researchers
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:

4. Conduct density sampling in adequate sample sizes to reflect population size.
   Responsible Parties:
   Timeline:
   Collaborators / Resources:

Costs:
Consequences:
Obstacles:

5. Continue determining the outline of the area of Black-tailed Prairie Dog colonies.
Responsible Parties: Parks Canada and Saskatchewan Environment
Timeline: Ongoing, every XX years
Collaborators / Resources:
Costs:
Consequences:
Obstacles:

6. Conduct studies and monitoring to determine Prairie Dog densities.
Responsible Parties:
Timeline:
Collaborators / Resources:
Costs:
Consequences:
Obstacles:

7. Create new modeling scenarios for Prairie Dogs based on local demographics where possible and from literature where not known locally.
Responsible Parties: Parks Canada and researchers
Timeline: Fall 2005
Collaborators / Resources: USGS, US land management agencies, US BTPD management groups and plans, Predator Alliance, Parks Canada, Saskatchewan Environment
Costs: <$10,000
Consequences: Better understanding of ferret carrying capacity; greater knowledge of prairie dog system
Obstacles: Cost, timeframes, stakeholder access, standardization of protocols

Goal

Understand the impact and interactions of Black-footed Ferret recovery on other prey species and predators particularly Species At Risk. The black-footed ferret may prey upon burrowing owls, sage grouse nests, etc. The diet of the ferrets after release should be evaluated to determine if SAR are a significant diet item. In addition, nest monitoring of Burrowing Owl and Sage Grouse may be required to determine if Black-footed Ferret are depredating their nests.

<u>Actions</u>

1. Analyze scat to determine diet of ferrets after release. Scat analysis will show the prey of bf including any SAR. However, some diet items such as eggs may be poorly represented in scat (e.g. only the content of eggs with no shell may be consumed and thus not detected in scat)
Responsible Parties:
Timeline:
Collaborators / Resources:
Costs:
Consequences:
Obstacles:

2. Monitor nests of burrowing owls and sage grouse if nest mortality is found to be high in the first years after release. If ferrets have pit tags installed, ring monitors at bird nests will detect any visits by ferrets. Camera monitors (digital and VHS) could be used to collect more detailed information on visits to nests.

Responsible Parties:
Timeline:
Collaborators / Resources:
Costs:
Consequences:
Obstacles:

3. Study other predators to determine the interactions with ferrets.
   Responsible Parties:
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:

Goal

Assess disease risk for the diseases that relate to black-tailed prairie dog and black-footed ferret.

<u>Actions</u>

1. Assess direct (e.g. predation) and indirect (e.g. habitat) disease prevalence, distribution and other risk factors in prairie species as it relates to black-footed ferret / black-tailed prairie dog
   Responsible Parties:
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:
2. Assess prevalence of distemper and (List diseases) in black-footed ferret, coyotes etc.
   Responsible Parties:
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:
3. Monitor for prevalence of distemper in coyotes, black-tailed prairie dog, etc in the region and specifically in the release complex.
   Responsible Parties:
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:
4. Assess risk for disease to black-tailed prairie dog and black-footed ferret
   Responsible Parties:
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:

Goal

Expand black-footed ferret habitat and, by extension, ferret carrying capacity. Ferret populations will be limited by the area of black-tailed prairie dog in the GNP area. In order to increase the carrying capacity of ferrets, existing colonies need to expand and additional colonies created.

<u>Actions</u>

1. Expand black-tailed prairie dog colonies in order to increase black-footed ferret carrying capacity by 25% by 2015.
   Responsible Parties: Fargey, Sissons, Parks Canada
   Timeline: Ongoing
   Collaborators / Resources: Parks Canada, SAF, SE and PFRA
   Costs:
   Consequences: Increased ferret habitat, potential decrease in available habitat for other Species at Risk
   Obstacles: Stakeholder involvement, cost, biological feasibility, environmental disruption

2. Select and prioritize areas for translocation of prairie dogs.
   Responsible Parties: Parks Canada
   Timeline: Ongoing pre- and post-release
   Collaborators / Resources: Parks Canada, USGS, Prairie Wildlife Research, all US reintroduction sites
   Costs: >$10,000
   Consequences: Increase of ferret habitat
   Obstacles: Park management plan, stakeholder opposition

3. Determine the use of alternate prey. Richardson's ground squirrel may be a viable alternate prey for ferrets. After the release of Black-footed Ferret, its diet needs to be determined to establish the use of alternate prey including ground squirrels. Ground squirrels occur in prairie dog colonies and in some areas outside colonies.
   Responsible Parties:
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:

4. Determine the abundance of ground squirrels in black-tailed prairie dog colonies and surrounding grasslands. With the release of bison in the west block, grasslands are likely to be more suitable for ground squirrels. Numbers can be expected to expand in the next years.
   Responsible Parties:
   Timeline:
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:

5. Evaluate the impact and need to dust burrows with insecticides to reduce the risk of plaque to black-tailed prairie dog. Fleas that carry plague can be reduced through insecticides. However the effect of the insecticide and its application is not specific. Thus all invertebrates would be controlled through the applications. The environmental impact of such an application needs to be evaluated. Currently a US study is evaluating the impact of insecticides on invertebrates in prairie dog colonies. Since plague antibodies have been identified in domestic dogs and cats in the region, plaque is a threat to black-tailed prairie dog colonies. However the prevalence

of plaque is 4% which is less than in US carnivores, and plaque is not known to have occurred in prairie dog colonies in Saskatchewan. Thus the immediate risk of plague is presumed to be low.
Responsible Parties: Parks Canada
Timeline: ASAP
Collaborators / Resources:
Costs:
Consequences:
Obstacles:

Goal

Improve our understanding of black-footed ferret demography in Canada at the northern edge of their range. Prairie dogs in Saskatchewan have extreme conditions, hibernate, and weigh more than southern populations. Little is known about most demographic parameters in this northern population. This information is needed to better determine the carrying capacity of colonies to support ferrets.

<u>Actions</u>

1. Explore viability of alternate prey items.
   Responsible Parties: Parks Canada and researchers
   Timeline: Ongoing and post-release
   Collaborators / Resources: USGS, US land management agencies, US BTPD Management groups and plans, Parks Canada, Saskatchewan Environment
   Costs: $10,000
   Consequences: Better understanding of ferret carrying capacity; greater knowledge of prairie dog system
   Obstacles: Cost, timeframes, stakeholder access, standardization of protocols
2. Determine productivity and mortality rates in Canada.
   Responsible Parties: Parks Canada and researchers
   Timeline: Ongoing and post-release
   Collaborators / Resources: USGS, US land management agencies, US BTPD Management groups and plans, Parks Canada, Saskatchewan Environment
   Costs: $10,000
   Consequences: Better understanding of ferret carrying capacity; greater knowledge of prairie dog system
   Obstacles: Cost, timeframes, stakeholder access, standardization of protocols
3. Determine the ecological carrying capacity for black-footed ferret in Saskatchewan.
   Responsible Parties: Parks Canada and researchers
   Timeline: Pre- and post-release
   Collaborators / Resources:
   Costs:
   Consequences:
   Obstacles:
4. Determine life history demographics in the release population.
   Responsible Parties: Parks Canada and researchers
   Timeline: Pre- and post-release
   Collaborators / Resources:
   Costs:
   Consequences:

International Black-Footed Ferret Recovery Workshop

Calgary, Alberta, Canada
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FINAL REPORT

Section III
Working Group Report: Population Biology and Simulation Modeling

Working Group Report: Population Biology and Simulation Modeling

Working Group Participants:
Sam Barry, Canadian Wildlife Service
Pat Fargey, Grasslands National Park
David Gummer, Provincial Museum of Alberta
Travis Livieri, Prairie Wildlife Research
Colleen Lynch, American Zoo and Aquarium Association
Kent Prior, Parks Canada
Kathy Traylor-Holzer, Conservation Breeding Specialist Group
Joanne Tuckwell, Parks Canada

This working group was tasked with modeling potential scenarios for the reintroduction and subsequent supplementation of black-footed ferrets (BFF) to Grasslands National Park (GNP), Saskatchewan, Canada. The *Vortex* population simulation model (v9.51) was used to assist in this process. Data from working group members as well as expert opinion and data from other workshop participants were used in developing and parameterizing this model.

Target Species

The first issue that was discussed was whether to develop a black-footed ferret model or if it would be more beneficial to model black-tailed prairie dogs (BTPD) instead of or in addition to ferrets. Black-footed ferrets are obligate predators and depend upon prairie dog populations; therefore, the presence and size of prairie dog colonies likely determine the carrying capacity (K) of areas for ferrets. Events that affect prairie dog populations, such as drought or disease, will also affect ferret populations. Given the lack of available data for black-tailed prairie dog/ferret interactions in habitat similar to that within the park, the group concluded that modeling prairie dogs to simulate effects on ferret populations was not feasible at this time.

The group decided to develop a black-footed ferret model to address the issues for this workshop. This will require certain assumptions regarding how changes in prairie dog populations affect ferret populations. It was agreed that the ideal model would be a two-species predator-prey interactive model that could address this inter-species relationship. While beneficial, the development of such a model was beyond the scope of this workshop.

Population Goals

The working group agreed upon the importance of discussing and setting black-footed ferret population goals for Canada *a priori* before examining model structure and results. Goals were framed in the context of extinction risk over a set period of time. Discussions within the workshop plenary sessions and considerations of goals previously set for U.S. and Mexican black-footed ferret sites guided the group in their decision. The working group recommended an acceptable level of extinction risk to be less than 10% probability of extinction in GNP over 50 years.

Couching goals in terms of genetic variation retained by reintroduced populations over time was considered to be inappropriate in this case due to the challenges inherent in the genetic management of reintroduced black-footed ferret populations. These challenges include low variation in the source (captive) population and limitations in monitoring descendant populations of reintroduced stock. While genetic management of these populations may be implemented, genetic goal-setting was not included at this time.

It is important to acknowledge that goals for the reintroduced population will be fluid in response to the impact of reintroduction on other populations of Species at Risk (SAR) within GNP. The sage grouse is of special concern, and expanding prairie dog habitat to facilitate ferret recovery may have negative impacts on sage grouse habitat.

PVA Model Development

Computer modeling is a valuable and versatile tool for assessing risk of decline and extinction of wildlife populations. Complex and interacting factors that influence population persistence and health can be explored, including natural and anthropogenic causes. Models can also be used to evaluate the effects of alternative management strategies to identify the most effective conservation actions for a population or species and to identify research needs. Such an evaluation of population persistence under current and varying conditions is commonly referred to as a population viability analysis (PVA).

This population model was designed to assess the viability of a reintroduced population of black-footed ferrets (*Mustela nigripes*) in Grasslands National Park using the simulation software program *Vortex* (v9.51). *Vortex* is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild populations. *Vortex* models population dynamics as discrete sequential events that occur according to defined probabilities. The program begins by creating individuals to form the starting population and stepping through life cycle events (e.g., births, deaths, dispersal, catastrophic events), typically on an annual basis. Events such as breeding success, litter size, sex at birth, and survival are determined based upon designated probabilities. Consequently, each run (iteration) of the model gives a different result. By running the model hundreds of times, it is possible to examine the probable outcome and range of possibilities. For a more detailed explanation of *Vortex* and its use in population viability analysis, see Lacy (1993, 2000) and Miller and Lacy (2003).

As a starting point the working group examined the black-footed ferret population model developed at the CBSG Black-Footed Ferret Population Management Planning Workshop held in Denver in 2003. This model was developed using *Vortex* to assess the viability of the U.S. black-footed ferret populations. Demographic inputs for the model were based largely upon monitoring data collected on the ferret population at Conata Basin, South Dakota, which represents the largest wild BFF population and is free from effects of sylvatic plague. Since no wild ferrets currently exist in Canada, this Conata Basin model served as a foundation for the proposed reintroduced Canadian ferret population and was modified as appropriate to create the GNP model. Discussions of specific revisions to the Canadian model are summarized below. Input values for the resulting baseline model and alternative scenarios can be found in Appendix I.

Population Structure

Potential ferret sites in the GNP area include both park lands (Larson block) and adjacent ranch lands (Dixon block). The working group considered whether to model GNP ferret reintroduction as a single population encompassing both blocks, or to model reintroduction with the Larson and Dixon blocks as two components of a meta-population with some degree of connectivity.

Information from observed ferret dispersal at other reintroduction sites suggests that the distance between the two blocks is not sufficient to discourage movement of ferrets between blocks. Consideration was also given to potential differences in land management strategies and resulting differences in demographic rates between the blocks. Potential for ferret movement between blocks was assumed to be so great as to likely overcome differences in block management. Both blocks were therefore treated as a single population within the model.

Carrying Capacity

Various carrying capacities for ferrets in GNP have been suggested. Carrying capacity of black-footed ferrets in GNP is highly dependent on black-tailed prairie dog population size and density. Density measures for prairie dogs within the Larson and Dixon blocks have been estimated using 4 ha visual counts. The error in density measures is high and the direct relationship between prairie dog density and ferret territory size is unknown.

An attempt was made at the workshop to define the relationship between ferret territory size and prairie dog density, but this became problematic due to methodological differences among projects. The best data were from Conata Basin, which suggest that female ferret territory size ranges from 30 ha (in crowded conditions) to 80 ha (possibly more realistic). The Larson and Dixon blocks encompass about 980 ha of prairie dog towns. Using a 30 ha female territory size results in a female K of 33. Applying a 1:2 sex ratio results in a total expected K of approximately 50 black-footed ferrets for the Larson and Dixon blocks. Applying the same calculations using an 80 ha female territory size results in a female K of 12 and a total K of 18. For modeling purposes, the current K was estimated to be between 20 to 50 ferrets. It may be possible to increase carrying capacity to 70 by increasing prairie dog populations and habitat within GNP through management. Most scenarios were run with K equal to 20 (minimum estimate), 50 (maximum estimate), and 70 (increased management) to assess current and potential future scenarios.

Reintroduction and Supplementation

Expert opinion at the workshop estimated that on average 40 black-footed ferrets (of equal sex ratio) would be available annually for release, and that this number might be even higher for the initial release into GNP. Expected 30-day post-release mortality was estimated at 75% based on releases of captive-born ferrets in the U.S. For modeling purposes, this expected mortality was applied to individuals prior to release, such that release events modeled only the surviving ferrets. For example, for an actual release of 40 individuals, 10 surviving individuals were released in the model scenario; these ferrets then were subjected to the same sex- and age-specific mortality rates applied to all ferrets in the model.

Given the expected high mortality associated with release, it is unlikely that releases of fewer than 20 individuals would be considered. Larger release cohorts are preferred. Model scenarios included initial releases of 20, 40, 60, and 80 ferrets into GNP. In addition to no supplementation after initial release, two subsequent supplementation schedules were also modeled: these consisted of supplementation of 40 ferrets per year for either the first 5 or first 10 years, with additional supplementation whenever the population fell below 20% of carrying capacity.

Sylvatic Plague

Sylvatic plague can have significant effects on ferret populations primarily through outbreaks in prairie dog colonies, effectively reducing the carrying capacity for ferrets (although plague can also affect ferrets directly). Plague was not incorporated into the Conata Basin BFF baseline model, but several scenarios were developed to explore the potential effects of plague. In these scenarios, plague events occurred with a 5% annual probability and resulted in a 50 or 75% reduction in K with each event. Ferret populations slowly recovered to pre-plague numbers over the subsequent six years. These estimates were derived from the personal experience of Denver workshop participants who had observed the effects of plague.

Plague has not been recorded in GNP and therefore it was not included as part of the baseline model. Three plague scenarios were run, under minimum, maximum and expanded K, using a 50% reduction in K to assess the effects of plague should it occur in GNP. Sylvatic plague is considered to be perhaps the greatest obstacle to BFF recovery in the U.S., and the working group recognized the need to protect the GNP prairie dog population from plague outbreaks and support further plague research.

Drought

Drought impacts primary productivity in the prairie ecosystem and undoubtedly impacts prairie dog populations and, in turn, black-footed ferret populations. The extent of this impact and the relationship between prairie dog and ferret densities is unclear, but prairie dog densities have been observed to decline up to 80% in response to drought. Weather data from Environment Canada (EC) for the GNP area from 1953 to present was used to estimate drought frequency. By defining a drought year as one in which the May-August rainfall was one standard deviation or more below the mean, historical data indicate that single-year droughts occur every 7-9 years and severe droughts (multi-year, averaging three years) occur about every 17 years.

Based on observations in the U.S., drought is believed to have a greater impact on ferret reproduction than on adult survivorship, with fewer kits being produced in years of drought. Multi-year droughts are of special concern, as the female life expectancy is less than three years and could result in an inability of the population to recruit breeding females.

Single year droughts were incorporated into the GNP baseline model through environmental variation in mortality rates. Multi-year droughts were not included in the baseline model but were explored through sensitivity analysis as a catastrophe with a probability of occurrence of 6%. The expected reduction in litter size was incorporated through a reduction in female reproduction rates (i.e., percent of females breeding). Drought effects lasted for 3 years, with the average percent of females breeding declining from 98% in non-drought years to 73.5% in the first year, 49% in the second year, and 24.5% in the third year of severe drought (based on expert opinion from observations in Conata Basin).

Other weather-related extreme events may also occur in GNP but are believed to be encompassed by the environmental variation in demographic rates in the model. One possible omission could be the effect of severe winters, which may impact ferret populations in Canada differently than in South Dakota.

Inbreeding Depression

Inbreeding depression is potentially of great concern to black-footed ferret recovery efforts. The source of animals for reintroduction within GNP is the captive population managed by the Black-footed Ferret Species Survival Plan (all reintroduced ferrets descend from this population, and translocation is unlikely at this time). Average inbreeding coefficients in the captive population approach F = 0.12. As of this time, no anecdotal evidence suggests inbreeding depression in the captive population in spite of the moderately high level of inbreeding. Systematic evaluation of the relationship between inbreeding coefficients and population vital rates has not been conducted. The North American Regional Black-footed Ferret Studbook database is currently being modified to allow examinations of inbreeding depression in the captive population.

In the absence of information on inbreeding effects for wild black-footed ferret populations, participants at the 2004 Denver meeting chose not to include inbreeding depression in the U.S. Conata Basin ferret model; this strategy was adopted for the GNP baseline model as well. Additional scenarios were modeled with inbreeding depression as a preliminary assessment of potential impacts to population viability. These scenarios were based on the average impact of inbreeding on juvenile mortality across 40 mammalian species (Ralls *et al.* 1988). Expression of inbreeding depression, however, is highly species and population specific. Once the results of studbook analysis become available, the effects of inbreeding can be more accurately assessed for ferret populations.

Modeling Issues and Goals

In developing and parameterizing the ferret model, the working group encountered several areas of uncertainty or other modeling problems. In some cases, additional research is needed to increase understanding of black-footed ferret and black-tailed prairie dog biology and ecology to improve model validity. The group identified the following areas of concern:

- Black-tailed prairie dog dynamics are complex and are not included in this model in an interactive way.
  Goal: Develop a way to model both species interactively and simultaneously. Explore other software options in addition to VORTEX.

- The data used in the GNP ferret model are not specific to Canada but are based on data from the U.S.
  Goal: Collect and incorporate Canadian data as available with reintroduction and recovery.

- There is a great deal of uncertainty and lack of information surrounding many of the input values used in the model.
  Goal: Continue model development as an iterative process as new data become available from Canada and/or the U.S. and Mexico.

- There is a potential for negative impacts of recovery and/or management on the viability of captive populations as a source for wild populations.
  Goal: Incorporate this consideration into the larger recovery evaluation.

- The unit of interest is the entire ecological community, not just two species for which we have a legislative responsibility.
  Goal: Use the results of these modeling efforts in an overall ecosystem plan to inform overarching ecosystem management decisions.

- There is a lack of understanding and data on the entire northern mixed grass ecosystem (e.g. black-footed ferrets, black-tailed prairie dogs, burrowing owls, vegetation community, sage grouse).
  Goal: Collect data on the entire ecosystem and all of its components to fit into the larger northern mixed grass conservation plan as well as the individual ferret model.

These preliminary goals were consolidated into the following working group goals:

1. Refine evidence-based knowledge of ferret life history, particularly Canada-specific information. Information needed includes carrying capacity, mortality rates, reproductive rates, environmental variation (e.g., drought, plague, severe winters), and inbreeding.

2. Refine evidence-based knowledge of black-tailed prairie dog life history, particularly in Canada, and develop a BTPD model.

3. Gather evidence-based knowledge of ecological community relationships for ferret communities and develop an ecosystem/community model.

4. Assess the effects of captive population viability on wild ferret/black-tailed prairie dog population recovery.

The first two goals were among the top-ranked goals across all workshop participants and are considered high priority for ferret recovery.

Model Results

Each stochastic model scenario was run for 500 iterations to produce a distribution of likely future trends and assess extinction risk. Population projections were modeled for the next 50 years, which represents about 30 ferret generations and coincides with population goals.

Deterministic Output & Model Validation

The demographic rates (reproduction and mortality) included in the baseline model can be used to calculate deterministic characteristics of the model population. These values reflect the biology of the population in the absence of stochastic fluctuations (both demographic and environmental variation), inbreeding depression, limitation of mates, supplementation, and harvest. It is valuable to examine these values to assess whether they appear realistic for the species and population being modeled.

The values chosen for the GNP ferret model result in the same deterministic growth rate (r_{det}) as the Conata Basin model, with $r_{det} = 0.436$ ($\lambda = 1.547$). This represents an annual potential growth rate of about 55%. Generation time (the average age of reproduction) is 1.7 years for both sexes. Adult sex ratio is 1.86 females per adult male. Estimates at the 2003 Denver workshop suggest that captive ferret populations have the potential to more than double in number each year under high productivity conditions. Overall, these population characteristics were accepted as realistic for this fast reproducing species.

At the 2003 Denver workshop, the Conata Basin ferret model was evaluated against field data collected for that population from 1996-2002 and was determined to do a reasonable job of tracking observed population trends. The Conata Basin model was considered to be a good representation of wild ferret populations free of major disease threats such as plague, and was suggested as a template for modeling ferrets in disease-free habitats (CBSG, 2004). No data are available on ferret populations in Canada before they were extirpated and therefore this model cannot be validated against data on Canadian ferret populations. Until data are available that suggest the need for model revision, the input parameters used in this analysis appear to be representative of wild ferret population dynamics.

Reintroduction Strategies

The recovery of black-footed ferrets in GNP will mean the reintroduction of ferrets into the currently available habitat containing black-tailed prairie dog colonies. A matrix of possible habitat carrying capacities (K) for ferrets and the potential number of ferrets used for the initial release (R) were investigated through model scenarios to assess population viability at different Ks and with different release efforts. Model results after 50 years can be found in Table 1.

Carrying capacity, which determines population size, is a primary factor in assessing extinction risk of a reintroduced ferret population (Figs. 1 & 2). In the absence of supplementation, a reintroduced population with a K of 20 to 30 ferrets has a high risk of extinction (61% to 92%). Although stochastic growth rates are positive (r = 0.014 to 0.068), stochastic risks associated with small populations lead more often to the loss of these relatively small populations. Only populations with K $\geq$ 60 have a relatively low risk of extinction over 50 years. Those populations that persist average about 2/3 K despite size of initial release, possibly due to density-dependent mortality. When averaged across iterations, these populations appear relatively stable; however, single iterations suggest fairly substantial fluctuations in population size from year to year. Smaller populations lose gene diversity faster due to genetic drift. Fewer founders (smaller initial release) also lead to a slightly greater loss in gene diversity (Table 1).

Table 1. Model results at 50 years for scenarios varying K (20 to 90) and size of initial release (20 to 80). PE = probability of extinction; mean N = mean population size; GD = gene diversity.

	PE				**Mean N (extant)**				**GD**			
K	**R20**	**R40**	**R60**	**R80**	**R20**	**R40**	**R60**	**R80**	**R20**	**R40**	**R60**	**R80**
20	0.896	0.886	0.918	0.870	13	14	13	13	0.08	0.10	0.09	0.08
30	0.614	0.558	0.556	0.508	20	20	20	20	0.14	0.20	0.22	0.21
40	0.386	0.326	0.298	0.300	26	26	27	26	0.24	0.27	0.29	0.29
50	0.270	0.154	0.210	0.170	33	34	34	33	0.31	0.35	0.39	0.38
60	0.202	0.120	0.140	0.098	41	42	41	41	0.37	0.40	0.42	0.44
70	0.182	0.104	0.070	0.076	48	48	49	47	0.39	0.47	0.48	0.50
80	0.160	0.060	0.060	0.072	54	56	54	54	0.42	0.50	0.52	0.54
90	0.130	0.056	0.058	0.054	60	62	61	63	0.47	0.53	0.55	0.58

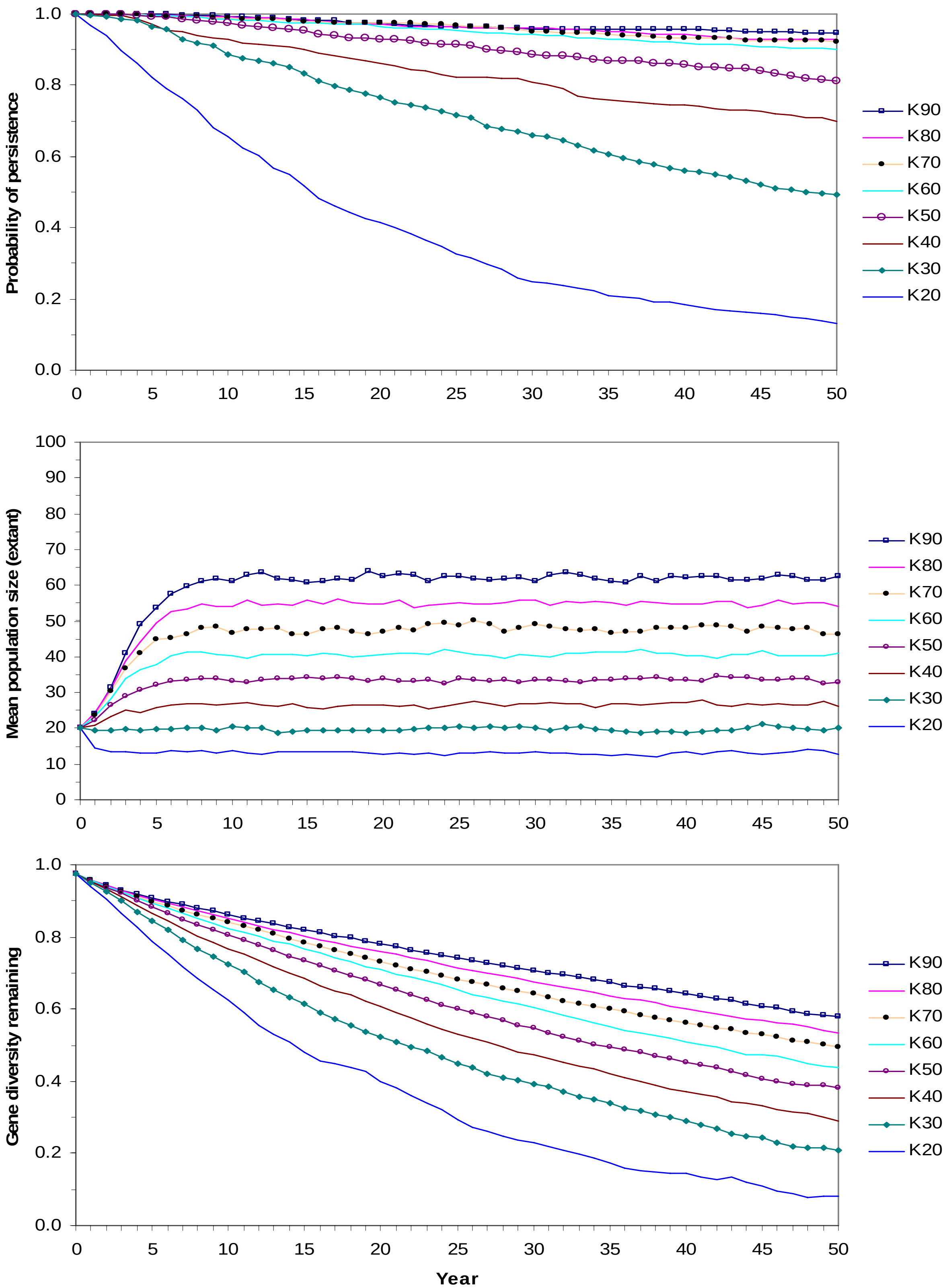


Figure 1. Effect of varying K on probability of persistence, mean population size of surviving populations, and gene diversity, with initial release of 80 ferrets and no supplementation.

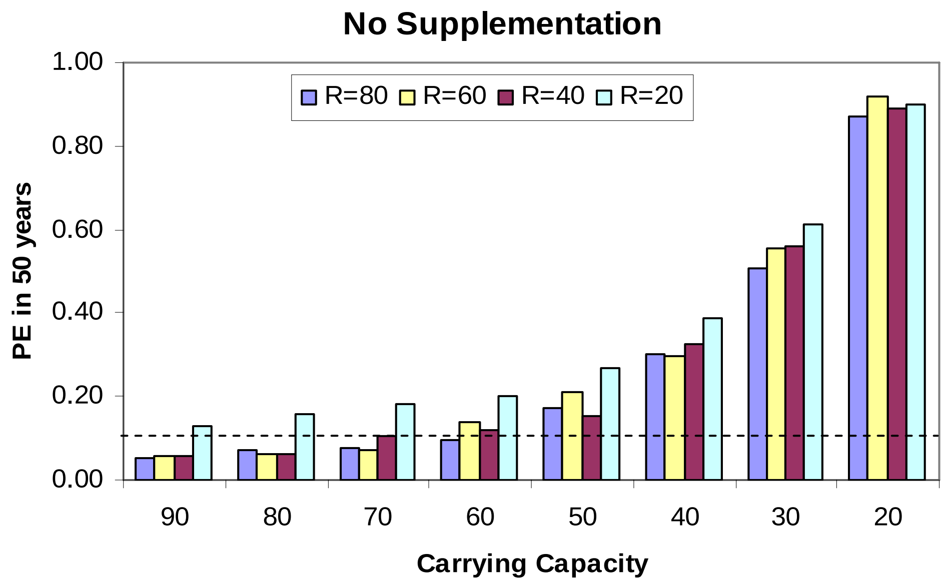


Figure 2. Effect of K and number of ferrets released on probability of extinction (PE), with no additional supplementation of ferrets. Dashed line indicates population goal of 10% PE.

Initial releases of only 20 ferrets (effectively 5 ferrets, given 75% post-release mortality) are associated with higher risk of extinction than larger reintroduction attempts of at least 40 ferrets. This is particularly true for larger populations (larger K). With an initiation release of 80 ferrets (20 after post-release mortality), populations with K of 60 or more meet the population goal of less than 10% risk of extinction in 50 years. Populations with K of 50 or lower, the estimated current carrying capacity for GNP, have a greater than 10% risk of extinction in 50 years without additional supplementation of the population. Risk of extinction changes dramatically across this probable range, indicating the importance in refining carrying capacity estimates for GNP.

Supplementation Strategies

Small ferret populations will be vulnerable to extinction and the loss of genetic variation due to genetic drift. It is likely that recovery of ferrets in GNP would include monitoring and supplementation of the reintroduced population. To assess the effects of supplementation over the continuum of likely conditions, three supplementation plans were evaluated (see below) over three carrying capacities that represent minimum estimated K (20), maximum estimated K (50), and increased K with management (70).

None: No supplementation after initial release of 80 ferrets

5Y: Release of 40 ferrets per year for the first 5 years following initial release of 80 ferrets; release of 40 ferrets in subsequent years if population size falls below 20% K

10Y: Release of 40 ferrets per year for the first 10 years following initial release of 80 ferrets; release of 40 ferrets in subsequent years if population size falls below 20% K

Supplementation after release can significantly reduce the probability of extinction, particularly for small populations (Table 2). This is not surprising, as supplementation occurs whenever populations fall below 20% K. This effect is most dramatic in small populations with high risk of extinction without supplementation (Fig. 3). Mean population size for surviving populations remains the same (approximately 67% K), while gene diversity increases with the addition of new genetic lines through supplementation. Extending annual supplementation from 5 to 10 years adds relatively little benefit as long as populations are supplemented as needed when below 20% K. All populations, regardless of K, have a risk of extinction < 5% in 50 years with supplementation, although they still lose significant genetic variation. Supplementation as needed may be a successful strategy for ensuring ferret population persistence but would require continual monitoring of the population.

Table 2. Model results at 50 years for scenarios varying K (20 to 70 ferrets) and supplementation strategy. PE = probability of extinction; mean N = mean population size; GD = gene diversity.

	PE			Mean N (extant)			GD		
K	**None**	**5Y**	**10Y**	**None**	**5Y**	**10Y**	**None**	**5Y**	**10Y**
20	0.870	0.042	0.034	13	14	13	0.08	0.52	0.53
50	0.170	0.000	0.002	33	34	34	0.38	0.52	0.53
70	0.076	0.002	0.002	47	49	47	0.50	0.59	0.63

Unfortunately, at the time of the workshop it was problematic to determine from the *VORTEX* output the frequency at which supplementation occurs. Certainly, smaller populations will require more frequent supplementation than larger ones in a non-linear manner. Rough estimates (calculated from population size at the end of each simulation year for individual iterations) suggest that populations with K = 50 may require supplementation about 2.5 times more frequently as those with K = 70, and populations with K = 20 about 14 times more frequently.

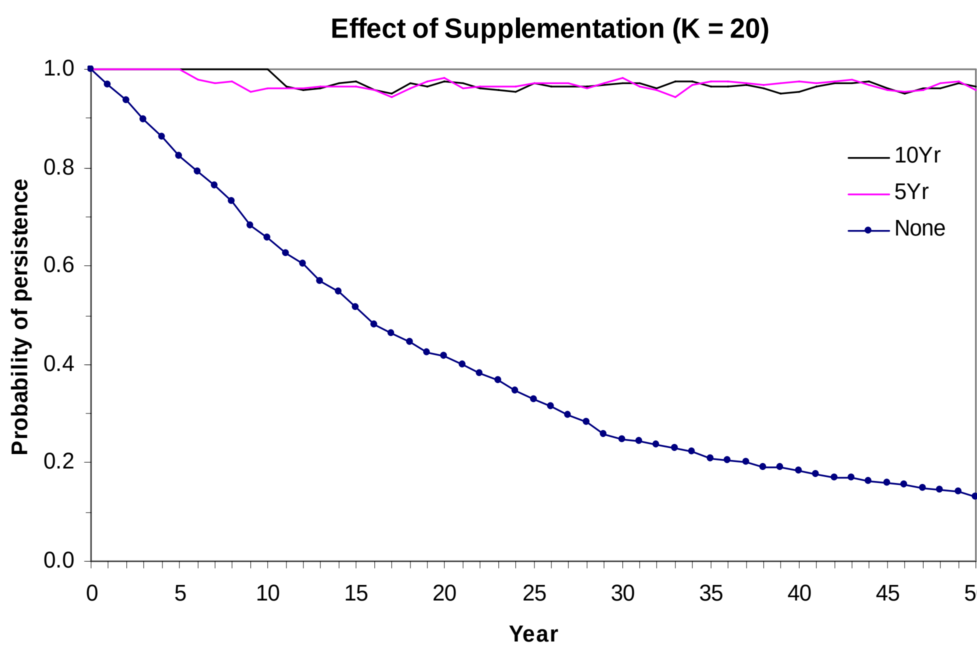


Figure 3. Effect of supplementation on probability of persistence when K = 20 (with addition of 40 ferrets annually for 5 or 10 years, and thereafter when N < 20% K).

Catastrophic Effects: Drought and Plague

The two catastrophic events of most concern for ferret and prairie dog populations in GNP are severe multi-year drought and outbreak of sylvatic plague. Droughts have been observed in GNP and were modeled as a progressive reduction in reproduction (% females breeding) over a three-year drought period.

Plague is unknown in the GNP prairie dog population but remains a potential risk to reintroduced ferret populations.
The addition of multi-year droughts to the GNP ferret model has little impact on model results. Extinction risk increases slightly for smaller populations (K = 20 or 50), but there is no effect on PE at K = 70 and no effects on mean size or gene diversity of surviving populations (Table 3).

The potential effects of plague, as modeled, are much more significant. Plague was estimated to occur approximately once out of every 20 years (5% annual probability of occurrence), reducing the prairie dog population to the extent that K for ferrets declines 50% for that year. These effects result in substantially higher probabilities of extinction (Fig. 4). Even larger ferret populations (K = 50 to 70) are highly vulnerable to plague (Fig. 5). Small populations (K = 20) have a high risk of extinction regardless of drought or plague in the absence of supplementation. These results emphasize the potential danger of sylvatic plague to a reintroduced ferret population, the importance of preventive measures to reduce the risk of plague outbreak, and the need for better estimates of the effects on plague on BFF populations to improve model accuracy.

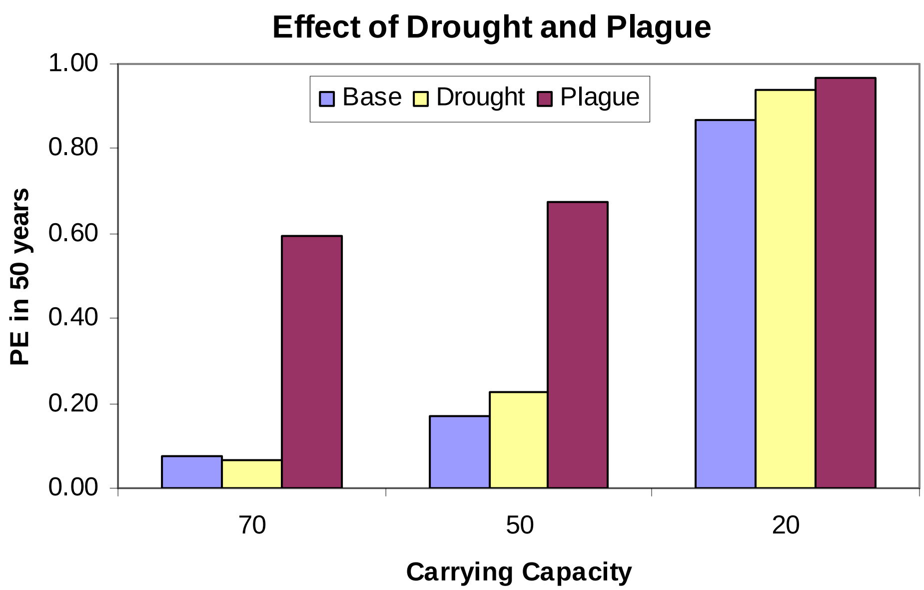


Figure 4. Effect of multi-year drought and plague on probability of extinction (PE), with no additional supplementation of ferrets.

In the model, supplementation can counteract most of the effects of severe drought and plague (Table 3). Populations that have declined to low numbers or even disappeared due to drought or plague could be supplemented once the immediate threat has passed. In reality, it may take longer to return to suitable conditions for supplementation than represented in the model; for instance, management decisions will need to be made whether or not to release more ferrets if plague is still prevalent in the prairie dog population. It is likely, however, that supplementation will be needed more frequently when the population experiences severe droughts, plague outbreaks, or other catastrophic events that lead to population decline.

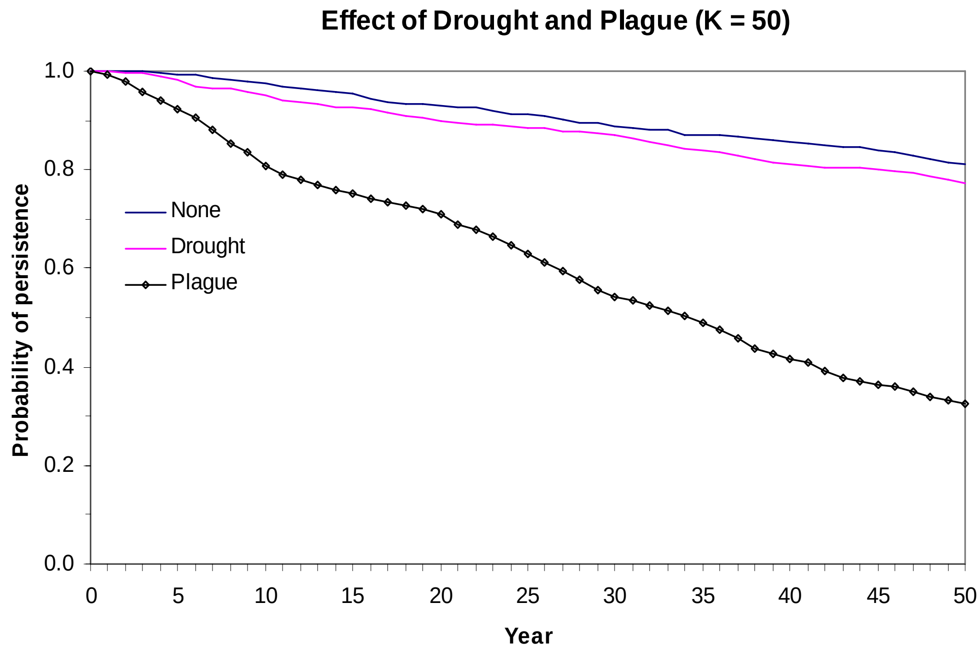


Figure 5. Effect of multi-year drought and plague on probability of persistence when K = 50, with no supplementation.

Effect of Inbreeding

All of the analyses presented so far assume that the reintroduced ferret population will not be susceptible to the effects of inbreeding depression. This may be unrealistic, as most species studied show some effects of inbreeding. Therefore, scenarios were also run incorporating the average effects of inbreeding on juvenile mortality observed in 40 mammal species in captivity. The actual sensitivity of this population to inbreeding depression may be less or greater than the effects modeled. The GNP *Vortex* model will also underestimate these average effects, as the model assumes all released ferrets are unrelated to each other; inbreeding will actually occur at a greater level than modeled due to the current level of inbreeding in the only available ferret source populations.

Even with the underestimation of inbreeding levels, inbreeding depression may have significant effects, particularly in small populations, leading to higher risk of extinction and smaller surviving populations (Table 3). In the absence of supplementation, populations with K = 20 have a 100% probability of extinction, with a mean time to extinction of 12 years. Populations with K = 50 are still highly vulnerable to inbreeding, with increased risk of extinction after 20 years and negative growth rates in surviving populations (Fig. 6). Populations with K = 70 are much less affected over a 50-year period.

As observed with other risk factors, supplementation removes the added risk of extinction due to inbreeding depression. Model results indicate that more gene diversity is retained under these conditions, as inbreeding depression acts to select against lethal alleles while supplementation provides new alleles. The actual genetic benefits of supplementation with ferrets from the same source population are likely to be less than modeled here.

Table 3. Model results at 50 years for baseline, drought, plague and inbreeding depression scenarios. PE = probability of extinction; mean N = mean population size; GD = gene diversity.

	PE				Mean N (extant)				GD			
No Supplementation												
K	**Base**	**Drght**	**Plague**	**Inbr**	**Base**	**Drght**	**Plague**	**Inbr**	**Base**	**Drght**	**Plague**	**Inbr**
20	0.870	0.940	0.968	1.000	13	14	15	--	0.08	0.14	0.05	--
50	0.170	0.226	0.676	0.652	33	33	32	14	0.38	0.34	0.33	0.31
70	0.076	0.066	0.592	0.194	47	45	46	23	0.50	0.47	0.43	0.39
Supplementation (40/yr for 5 yrs and when N < 20% K)												
K	**Base**	**Drght**	**Plague**	**Inbr**	**Base**	**Drght**	**Plague**	**Inbr**	**Base**	**Drght**	**Plague**	**Inbr**
20	0.042	0.046	0.056	0.040	14	13	13	11	0.52	0.57	0.60	0.71
50	0.000	0.008	0.018	0.000	34	33	30	25	0.52	0.52	0.59	0.66
70	0.002	0.002	0.004	0.002	49	46	44	35	0.59	0.60	0.65	0.63

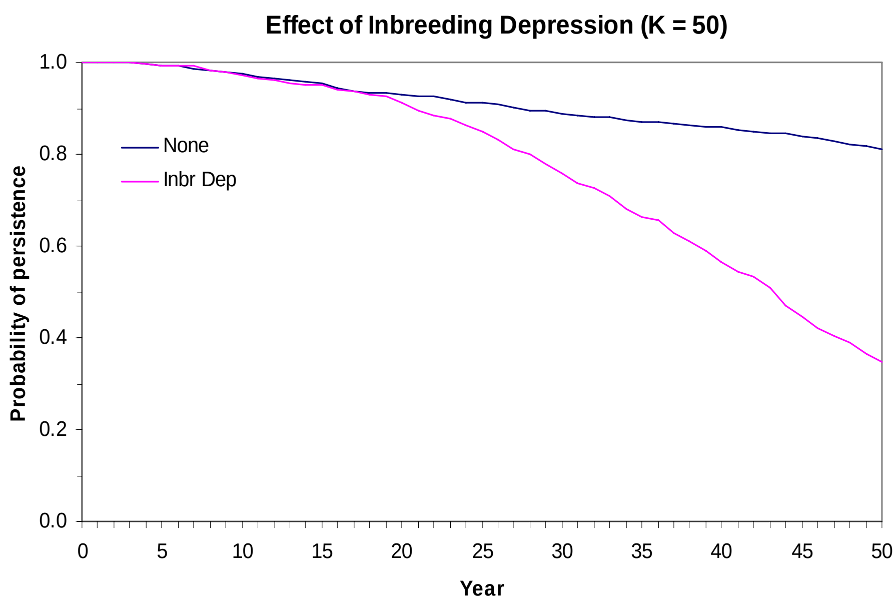
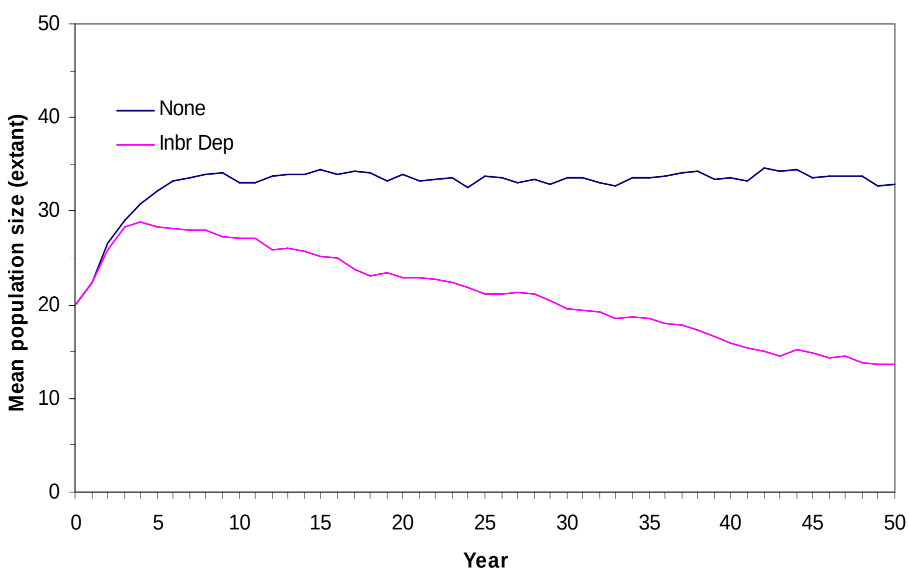


Figure 6. Effect of inbreeding depression on probability of persistence and mean population size when K = 50, with no supplementation.



The inbreeding model presented here is problematic, both in terms of the lack of data on the sensitivity of the black-footed ferret population to inbreeding depression and the relatedness of ferrets used to initiate and supplement this population. The results suggest, however, that inbreeding depression has the potential to reduce population viability and that these effects will be larger and experienced sooner in smaller populations.

Summary

The recovery of black-footed ferrets in Grasslands National Park is dependent upon viable black-tailed prairie dog populations of sufficient size to sustain a ferret population. Based on estimates of prairie dog densities in GNP, the best guess based on expert opinion at this workshop was that GNP may be able to sustain about 30 ferrets (20 minimum, 50 maximum). *Vortex* model simulations suggest that populations of this size are highly vulnerable to extinction and may require frequent supplementation to persist. Results suggest that at least 40 ferrets should be used in the initial release to promote successful establishment of a reintroduced population.

Workshop participants agreed that a reasonable target would be to have a carrying capacity of at least 50 ferrets in GNP. This underscores the importance of utilizing both park and ranch lands in ferret recovery. Even with these lands, achieving a carrying capacity of 50 ferrets may require management efforts to increase prairie dog numbers and habitat. Management that promotes prairie dog colonies may need to be evaluated in the larger ecosystem context to consider the potential impacts on other species at risk.

Sylvatic plague has the potential to severely impact ferret recovery. Precautionary measures to reduce the risk of plague in GNP should be considered as part of the recovery process. According to the assumptions that were made to parameterize these models, periodic drought appears to pose less of a threat to ferret population viability, but still has the potential to cause a population to decline or go extinct.

Supplementation has the ability to recover declining or extinct populations through demographic and genetic augmentation. A larger population will be less vulnerable to stochastic and catastrophic events and will require less supplementation and intensive management. It is very likely that the reintroduced ferret population will require some level of supplementation after the initial release unless carrying capability has been greatly underestimated or can be increased by two- or three-fold. As ferret recovery projects continue across the species' historical range, supplementation may be limited by the ability of captive or wild populations to produce ferrets available for these efforts. Likewise, as inbreeding levels increase in all ferret populations, inbreeding depression has the potential to reduce viability of both captive and wild populations.

Much of the data used to develop this BFF model for GNP was based upon information from the recovery of ferrets in the U.S. These data are limited and may differ from appropriate values for a more northern population in GNP. As more and better information becomes available, the ferret model for GNP can be refined to provide better projections of likely futures and management outcomes for this population. Greater understanding of the relationship between prairie dog and ferret populations and the development of a BTPD – BFF model may lead to a greater understanding of factors influencing black-footed ferret recovery in Canada.

Appendix I:
A *VORTEX*-Based Analysis of Supplementation Strategies

Joanne Tuckwell, Parks Canada

(Analyses completed subsequent to the formal close of the workshop)

Upon examination of the results from modeling the different supplementation strategies, the benefits of releasing ferrets each year for the first 5 years were questioned. After running the model at varying levels of K, it was found that the probability of extinction was not significantly decreased by supplementing ferrets each year for the first five years after the initial release. Therefore, it would not be necessary to supplement the population each year for the first 5 years, after initial release of 80 ferrets.

K	PE (Probability of Extinction) n=500			
	A	**B**	**C**	**D**
20	0.93	0.90	0.05	0.03
30	0.63	0.62	0.02	0.01
40	0.35	0.36	0.01	0.01
60	0.13	0.10	0.00	0.01
80	0.06	0.05	0.00	0.00

A = no supplementation
B = supplementation each year for the 1st five years after initial release and then no further supplementation
C = supplementation each year for the 1st five years, then only when N drops below 20% of K
D = supplementation only when N drops below 20% of K

The results of the model seem to indicate that supplementing the population only when it drops below 20% of K would be sufficient to avoid extinction. However, the question then arises as to how many times during a 50 year period the population would have to be supplemented (how many times does it drop below 20% of K?). If the model indicates that the population would have to be supplemented many times in those 50 years then perhaps releasing ferrets in Grasslands National Park is not feasible.

The results from modeling the supplementation of 5 ferrets each time the population drops below 20% of K (Scenario D) are:

K	# supplementations with 5 adult ferrets (2 male, 3 female) required over 50 years (n=500)	# extinctions over 50 years (n=100)
20	1.5	1.82
30	1.1	0.58
40	0.9	0.23
60	0.6	0.07
80	0.7	0.06

Therefore, from the resulting supplementations and extinctions, it seems as though supplementation rates required to prevent extinction of this population (even at K=20) would not be unreasonable and that releasing ferrets into Grasslands National Park is feasible.
On many occasions, once a population had gone extinct, the supplementation with 5 adults (2 male, 3 female) was not adequate to prevent a second extinction the following year and the population did not recover without a second or sometimes third consecutive supplementation. Further modeling is needed to determine if supplementing a larger number of ferrets (>5) at one time would help prevent these consecutive extinctions.

Appendix II: *VORTEX* input values for GNP black-footed ferret model

See text and 2003 Denver BFF workshop report (CBSG, 2004) for more information

Number of iterations: 500
Number of years: 50
Extinction definition: Only one sex remaining
Number of populations: 1
Inbreeding depression: No (baseline)
For inbreeding models, the impact of inbreeding was modeled as 3.14 lethal equivalents, with 50% of the effect of inbreeding due to recessive lethal alleles.
Concordance between environmental variation in reproduction and survival: No
No evidence that reproduction and survival are related; almost all females reproduce.
Number of catastrophes: 0 (baseline)
Severe drought and plague modeled as alternate scenarios as follows:
Drought: 6% annual probability; reduces % females breeding to 73.5% (Year 1), 49% (Year 2), and 24.5% (Year 3)
Plague: 5% annual probability; reduces K by 50% for one year
Mating system: Short-term polygyny
Age of first offspring: 1 year (both sexes)
Maximum age of reproduction: 4 years
Maximum litter size: 5
Density-dependent reproduction: No
Percent adult females breeding: 98% (EV=2%)
Distribution of litter size: 1 (0%); 2 (22.1%); 3 (54.9%); 4 (17.7%); 5 (5.3%)
Mortality: Density-dependent

Females	At low density	At N = K	Formula (mean)	Formula (EV)
0 – 1 yrs	35% (EV = 10%)	65% (EV = 19%)	35+(30*(N/K))	10+(9*(N/K))
1 – 4 yrs	40% (EV = 6%)	60% (EV = 9%)	40+(20*(N/K))	6+(3*(N/K))
Males	At low density	At N = K		
0 – 1 yrs	65% (EV = 9%)	80% (EV = 12%)	65+(15*(N/K))	9+(3*(N/K))
1 – 4 yrs	40% (EV = 6%)	0% (EV = 10%)	40+(30*(N/K))	6+(4*(N/K))

Monopolization of breeding: 100%
Initial Population Size: 20 (most scenarios, unless otherwise indicated) = release of 80 ferrets
Only 25% used to found population to adjust for 75% post-release mortality
Release of 80 = initial N of 20 (10 one-year-olds of each sex)
Release of 60 = initial N of 15 (8 females, 7 males, one-year-olds)
Release of 40 = initial N of 10 (5 one-year-olds of each sex)
Release of 20 = initial N of 5 (3 females, 2 males, one-year-olds)
Carrying capacity (K): Varies; 20, 50, 70 for most scenarios
Harvest: None
Supplementation: None, 5Y, 10Y
5Y = release of 40 BFF per year for the first 5 years following initial release of 80 BFF; release of 40 BFF in subsequent years if population size falls below 20% K
10Y = release of 40 BFF per year for the first 10 years following initial release of 80 BFF; release of 40 BFF in subsequent years if population size falls below 20% K

International Black-Footed Ferret Recovery Workshop

Calgary, Alberta, Canada
1 – 4 April, 2005

FINAL REPORT

Section IV
Working Group Report:
Community Involvement

Working Group Report: Community Involvement

Working Group Participants:
Bill Bristol, Prairie Farm Rehabilitation Administration
Tian Everest, Calgary Zoo
Pat Fargey, Grasslands National Park
Shin-ichi Hayama, Nippon Veterinary & Animal Science University, Japan
Sue McAdam, Saskatchewan Environment
Akira Murayama, Ministry of Environment, Japan
Lindsay Rodger, Parks Canada
Lorne Veitch, Saskatchewan Agriculture

General Problem Statement

Based on the results of the 2003 Denver PVA modeling workshop, the amount of available habitat within Grasslands National Park is below the accepted threshold for sustaining a viable population of black-footed ferrets. Therefore, additional land managers will need to participate in the ferret recovery effort in order for have a better chance of success.

Issues

- Multiple land managers have differing views on prairie dogs and ferrets that may require different approaches to their resolution. Some of the views are core values that are unlikely to change. Examples of these managers includes:
  Federal Government: PFRA, Parks Canada
  Provincial: Saskatchewan Agriculture, Saskatchewan Environment
  Ranchers: occupants and deeded owners
  Regional producers in proportion to proximity to the Parks Canada

- The current level of awareness of the plight of the black-footed ferret and its proposed recovery in Canada is low in the local community. These communities must be brought up to speed on the issues; such consultation is a legal requirement and it is the principled thing to do. The desired end result of such dialogue is the maintenance of a favorable political environment.
  In addition, it would be important to build a more broad constituency of support across regional and national audiences. This will assist in building institutional support (includes ENGO and other partners) and will likely lead to more secure funding

- Where is prairie dog expansion biologically feasible? Where, how, and how much? Where are people likely to tolerate the species? How would we be more effective in "selling" this idea to land managers? This information is vital if we intend to have an intelligent dialogue with local stakeholders. In addition, it would be worthwhile to identify strategies for compensating producers for tolerating new prairie dog colonies.

- We need to develop a compelling social and biological rationale for why ferret reintroductions within Canada are important.

- Will ferrets compete with other Species at Risk interests, e.g. effect of ferrets on the conservation of these species

Information Assembly and Analysis

Jurisdiction	Interests	Data Required	What we want	Fact/Assumption
Grasslands National Park	Park superintendent		Support	• Explore reintro in Mgmt Plan • Recovery Strategy • EA • Park colonies crucial to recovery (F)
	Management Plan		Strategy & EA reflected in plan	Redo by 2008
	Parks Canada Nationally		Resourcing	Strategy & EA
Existing PD Town partners	Dixon Ranch Co. & SAF	• Is the land deeded? • Are Habitat Stewardship Program (HSP) dollars available?	Accept more PD? Accept ferrets?	• Existing PD are OK (F – Sue M.) • Land is under a long lease • GNP may buy lease (F – Lorne V) • Colonies crucial to recovery (F)
	Frenchman Valley Cattle Co. & SAF	• Is the land deeded? • Are PDs OK? • Availability of HSP dollars?	Same as Dixon	• Lease as above • Gov't unwelcome • This colony is part of the Dixon Ranch complexes and ferrets may disperse to this colony
	Dixon Prov. Community Pasture, Patrons & SAF	• Who are all the patrons? • Are PD protected? • Would GNP consider grass or financial compensation for grazing loss? • Availability of HSP dollars?	Is colony req'd for release	• SSARR apply (F) • Patrons have negative view of PD (Cattle/loss of income) (F) • Small colony about 8km from main PD complexes (F)
	Masefield PFRA Community Pasture (CP), Patrons	• Who are all the patrons? • Are PD protected? • Would GNP consider grass or	Same as Dixon Pasture	• SARA applies • Patrons negative views of PD (Cattle/loss of income)

Jurisdiction	Interests	Data Required	What we want	Fact/Assumption
		financial compensation for grazing loss? • Availability of HSP dollars?		• Local PFRA CP tolerate current PD, negative to intentional expansion • Small and 8-10km from main PD complexes
Val Marie area	Town of Val Marie (Council)	• Position on PD & ferrets? • Methods to increase town support?	• No negative support, hopefully to positive support • Letters of support if others have negative view? • Inform/educate	Town residents Interested in economic dev. and positive image for town
	Early adopters	Who are they?	Full active support & influence	These people are viable in VM
	R.M of Val Marie	• Position on PD & ferrets • Methods to increase RM support?	No negative support, hopefully to positive support	• Farmers & rancher based group • More concern about $ loss
	Sask Stockgrowers Assn. (SSGA)	What support or concerns are there?	Consult to avoid future opposition	Rancher based, concerned about $ loss
	GNP Advisory Board	Levels of support?	• Consultation with board • Support	Assume some support
	Friends of GNP	Levels of support?	• Support • Educational/promotional initiatives	Assume some support
	GNP Steering Committee		Consultation on and support for project	
	Southwest Naturalists		Support	Support
East Block area	Towns of Mankota, etc.	Is this a potential PD site?	Maybe nothing?	
Political	AAFC **Management and Nationally**	Is PD expansion acceptable for Lone Tree or Val Marie CP?	• PD expansion sites and support • Need to consult and provide proposal	Ecosystem Mgmt with ferrets OK with convincing
	SAF Lands Branch Regina + Deputy/Minister		• Support for possible expansion • Need to consult and provide proposal	• Landowner • Current PD not an issue • Expansion neutral with compensation
	SE Resource Stewardship		Need to consult and provide proposal	Will issue permits

Jurisdiction	Interests	Data Required	What we want	Fact/Assumption
	Branch Minister			
	Sask. Assn. of Rural Municipalities (SARM)	How does ferret project affect tax base?	• Same as above • Need to consult and provide proposal including potential land base affected	
	Environment Canada (Geoff Holroyd)		• Consult about recovery development, CITES, SARA permits • Resourcing	SAR permit issuer
Institutional Support	SSGA		Consult & avoid derailment of project	
	Prairie Conservation Action Plan (PCAP) Members		Support, consult, educate, early adopter and influencer group	• Ferret is on the cover of the mag.? (Lorne) • SK Eco-ex • SE listens to them • SSGA co-chairs PCAP
	Nature Saskatchewan (NS)		Consult, support, educate	SK Eco-ex Provincial naturalist awareness
	Saskatchewan Watershed Authority (SWA) Minister		Stewardship activities with project partners	Active in the Frenchman Valley
	Wildlife Health Centre (WCVM)	Resources they need?	Ease concerns about disease transmission to stock, pets, etc.	
	Nature Conservancy of Canada (NCC)		Stewardship activities with project partners	landowner
	Frenchman R. Biodiversity Project (FRBD) (Royal Sask. Museum)			
	World Wildlife Fund		ESRF resourcing	Grasslands program, Recovery team resource person
	Calgary, Saskatoon, and Toronto Zoo		Ferrets, education, research	Saskatoon wants to participate, Calgary & Toronto are participants
	International Concerns USFWS		Consult with neighboring country	

Goals and Actions

Goal

Gain support or tolerance of black-footed ferret reintroduction and recovery from stakeholders in the core recovery area in and around Grasslands National Park (GNP).

Subgoal

Communication/consultation strategy followed by a communication plan for core area stakeholders

- Gain Dixon Ranch support for ferret reintroduction, release and recovery
- Gain tolerance of Walkers for ferret reintroduction, release and recovery
- Increase knowledge of ferret recovery throughout all levels of Parks Canada (including GNP staff) and gain their support.

Actions

1. Information package with general species and recovery strategy intent (what, when, where, why) to core stakeholders first
   Responsibility: Recovery Team and GNP
   Timeline: August 2005
   Measurable: pamphlet
   Partners: publishing contractor, USFW (BFFTIP), Recovery Team organizations
   Resources: info package creation and production resources (GNP), Recovery Team time (represented organizations)
   Consequences: well informed stakeholders on ferret recovery
   Obstacles: information not read
2. In person meetings with core stakeholders to answer questions about information package and provide specific information related to ferrets and prairie dogs on their ranch/park
   Responsibility: members of Recovery Team
   Timeline: beginning of Sept 2005
   Measurable: information provided to address core stakeholder concerns
   Partners: members of the Recovery Team
   Resources: Recovery Team time
   Consequences: dialog with core stakeholders
   Obstacles: unwilling or unfavorable response from core stakeholders. Core views of government, biologists and involved species may not be supported by stakeholders. Stakeholders may wish to avoid attention created by program.
3. Invite participation on recovery team and recovery activities such as releases and monitoring
   Responsibility: members of Recovery Team
   Timeline: beginning of Sept 2005
   Measurable: stakeholders have opportunity to attend/participate in ferret recovery efforts
   Partners: Recovery Team and core stakeholders
   Resources: Recovery Team time
   Consequences: dialog with core stakeholders
   Obstacles: unwilling or unfavorable response from core stakeholders
4. Gather feedback and revise recovery strategy accordingly
   Responsibility: members of Recovery Team
   Timeline: end of Sept 2005
   Measurable: meet legal requirements regarding consultation
   Partners: Recovery Team
   Resources: Recovery Team time

Consequences: legal consultation completed and modified recovery strategy moves forward through review process
Obstacles: extensive revision delay finalization of BFF recovery strategy or modify feasibility of the recovery strategy.

Goal

Expand black-footed ferret habitat

Sub-goal

Identify areas and stakeholders to grow black-tailed prairie dog colonies

<u>Actions</u>

1. Develop clear biological understanding of where ferret expansion is possible.
   Responsibility: members of Recovery Team, BFFTIP
   Timeline: 2006-2020
   Measurable: Feasibility of expansion determined biologically
   Partners: Universities, Recovery Team agencies, BFFTIP,
   Resources: Recovery Team and BFFTIP input, Research resources
   Consequences: Specific details of ferret and prairie dog requirements established for expansion areas
   Obstacles: Variability among models and environmental impacts on ferret population dynamics
2. Develop a priority listing as to which areas would contribute most to BFF recovery.
   Responsibility: members of Recovery Team
   Timeline: 2006-2020
   Measurable: Priority expansion areas are identified
   Partners: Recovery Team, BFFTIP, Universities
   Resources: Recovery Team and partners
   Consequences: Ranked inventory of potential expansion sites created
   Obstacles: Extinction of expanded prairie dog populations too high for successful ferret recovery.
3. Explore potential expansion with directly affected stakeholders in priority areas and modify ferret recovery strategy accordingly.
   Responsibility: members of Recovery Team
   Timeline: 2006-2020
   Measurable: Meet legal requirements regarding consultation. Confirm acceptability of expansion areas with core stakeholders.
   Partners: Recovery Team and their agencies
   Resources: Recovery Team and stakeholder input, specific communication package development if needed
   Consequences: understand stakeholder interests, strategy to accommodate stakeholder interests explored, legal consultation process conducted and modified recovery strategy to accommodate stakeholder interests as required
   Obstacles: Key agencies/stakeholders resistant to expansion of prairie dog / ferret habitat in identified priority areas. Extinction rates of expanded prairie dog populations are too high for successful ferret recovery.

International Black-Footed Ferret Recovery Workshop

Calgary, Alberta, Canada
1 – 4 April, 2005

FINAL REPORT

Section V
Working Group Report:
Mexican Population Management

Working Group Report: Mexican Population Management

Working Group Participants:
Rurik List, National University of México
Jesus Pacheco, National University of México
Juan Cornejo, Africam Safari / CBSG México
Axel Moehrenschlager, Calgary Zoo
Travis Livieri. Prairie Wildlife Research
Steve Forrest, World Wildlife Fund

Introduction

While there are no historical records of black-footed ferrets from Mexico (May, 1981), there are black-footed ferret fossil and sub-fossil remains associated with prairie dogs, and within the Chihuahuan Desert, north and south of the reintroduction area (Harris 1977; Messing 1986), and historic in the nearby San Pedro River, in Arizona, near the Mexican Border (Mearns, 1907). The close association of ferrets and prairie dogs throughout their range, suggests that ferrets were historically present in Janos, but not detected, as this region of Mexico was only thoroughly sampled for mammals until after the 1990's, time at which prairie dogs had dissappeared from large tracts of northern Mexico and canine distemper had already been established, so the ferrets had, most likely, dissappeared by then. The idea of the historical presence of ferreets in Janos is further sustained by the fact that species assemblages are considered better predictors of the presence of particular species in specific sites, than are museum records (Findley and Caire, 1977), and in the case of Janos, the vast majority of mammals species found in the Janos grasslands are also found in other ferret locations in the U.S. Given the above, it was considered that *Mustela nigripes* was more likely present in Janos at some point within historic times, than that it was absent. Finally, because of the grim situation of the black-footed ferret in the wild, a (re)introduction in Janos could become a significant contribution to avoid the extinction of a species from the grasslands of North America.

Problem Statement

Because of the large size of the Janos-Casas Grandes Prairie Dog Complex, which in 1988 included 55,000 ha of occupied towns (Ceballos et al. 1993), this area was considered as having the best potential to recover the black-footed ferret in the wild. However, by 2001, the occupied area had been reduced to over 20,000 ha (part of the reduction was due to greater accuracy in the measurements by the us of GPS technology) as a result of prairie dog poisoning, and to a lesser extent, agriculture expansion, the effects of droughts, and overgrazing (List, 1998; Marcé 2002). Nonetheless, the Janos area still maintained a high potential for the recovery of the species, and therefore, black-footed ferrets were released in "El Cuervo" prairie dog town, in Janos, from 2001 to 2003 (Lockhart et al 2003). While only a fraction of the released ferrets were detected in follow-up surveys, up to two-year survival was observed in several individuals, and wild-born ferrets were observed after the first breeding season, furthermore, all captured animals were in good physical condition, indicating suitable conditions for the establishment of a ferret population. After two-years of drought, and with virtually no vegetation cover, prairie dog numbers started to plummet and ferret monitoring efforts showed a decreasing number of ferrets.

The combination of drought, overgrazing by cattle and the expansion of agriculture have reduced and fragmented the formerly very large complex, reducing the potential to establish a self-sustaining ferret population. By 2004 the ferret releases were suspended because of the low prairie dog densities, as it was believed that the mortality risk for the released ferrets was much higher that the benefit of increasing the possibilities for the established surviving ferrets to find a mate to reproduce. This decision was taken with insufficient data and a population model could have helped to take a more informed decision. Future reintroduction efforts should, as minimum be guided by ferret population models, to determine if individuals are to be released, and their number.

We also identified a series of biological, social, and political factors that make recovery more difficult:

Biological:

- Drought may reduce prairie dog towns unpredictably –CP
- Climate change may have irreversible impacts in the long term (desertificaiton) -PC
- Shrub encroachment may invade prairie dog towns+EP
- Prairie dog colonies may be too small, isolated, or low density to sustain BFF.+HC
- Plague, which is not present now, may come into the populaiton unpredictably. -HC
- Distemper or Parvovirus may affect BFF, transferred from feral animals. -HC
- Predation on BFF may be large from wild or feral animals -HC

  We have an effect (+), We don't have an effect (-)
  Direct effect on ferret (H), Effect through Prairie Dog (P)
  Cause (C), Effect (E)

Sociological:

- Trapping
- Poaching
- Domestic dog and cat husbandry
- Agriculture expansion
- Overgrazing
- Poisoning
- Land use
- Habitat fragmentation

Political:

- State government opposition to reintroduction
- Insufficient monitoring
- Insufficient funding

The extent of prairie dog habitat fragmentation is shown in Figure 1 and Table 1. With the exception of the El Cuervo and Salto de Ojo-La Báscula colonies, all habitat fragments are less than 1000ha, with little or no connectivity between them. Prairie dog colony densities are presented in Tables 2 and 3. Note the extreme level of decline in density seen with within the current ferret reintroduction site.

Figure 1. Prairie dog towns mapped between September 1999 to March 2000 in Chihuahua, Mexico.

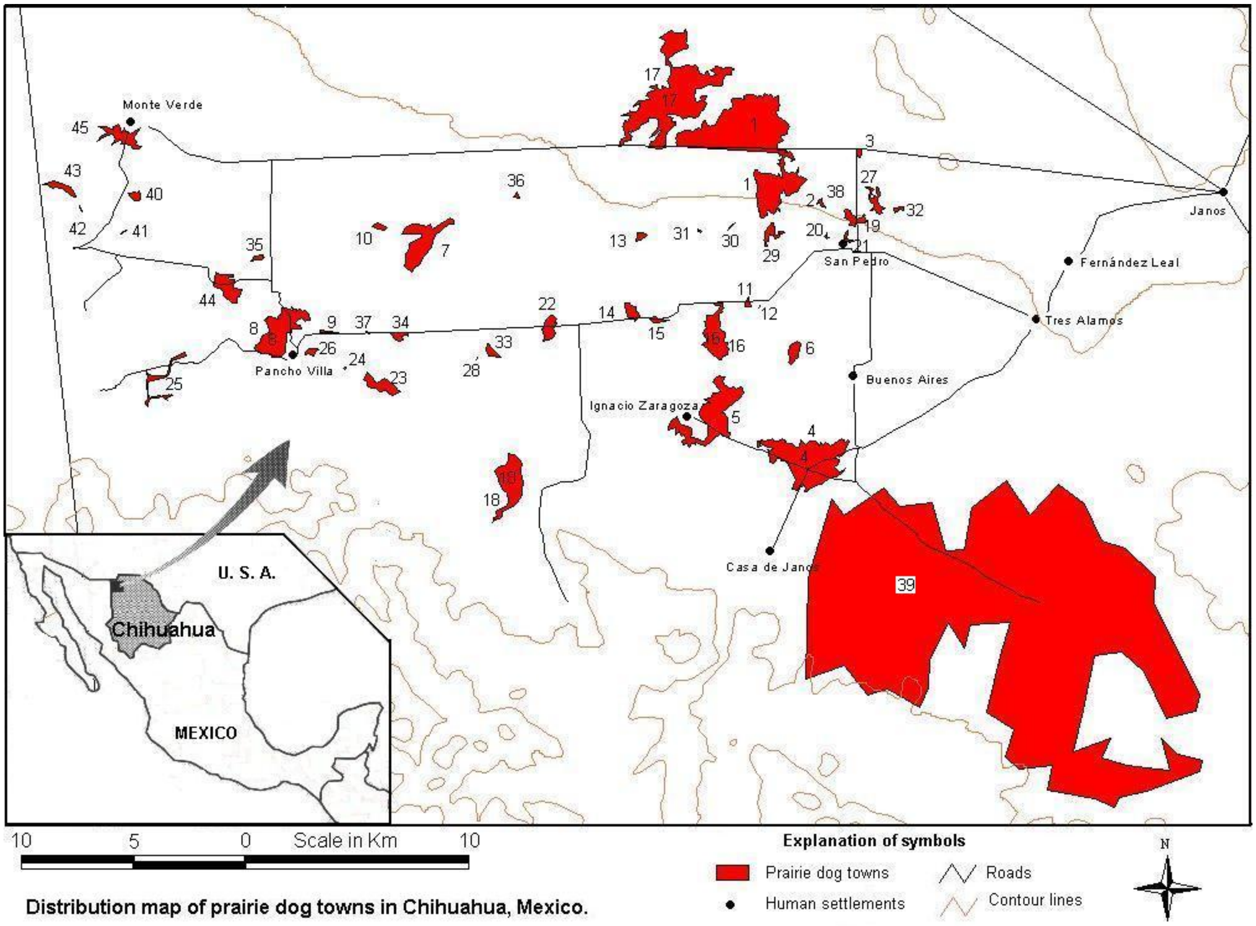


Table 1. Surface (ha) of prairie dog towns in Chihuahua, Mexico.

No.	Name	Area (Ha)	No.	Name	Area (Ha)
1	Salto de Ojo-La Báscula	1,270	24	Pancho Villa E2	1
2	El Gavilán N1	7	25	Pancho Villa W	45
3	El Gavilán N2	9	26	Pancho Villa NE1	14
4	Buenos Aires	579	27	El Gavilán NE	42
5	Tierras Prietas	390	28	Los Alisios	1
6	El Uno SSE	41	29	El Uno N	33
7	Los Bejucos	228	30	El Uno-Báscula S	1
8	Pancho Villa N	291	31	La Cal E	2
9	Pancho Villa NE2	7	32	El Gavilán E	7
10	Los Nogales	10	33	El Apache	19
11	El Uno S1	7	34	Los Bejucos S	21
12	El Uno S2	1	35	Rogelio	10
13	La Cal W	13	36	El Monte	4
14	Los Ratones SW	34	37	Los Bejucos SW	2
15	Los Ratones S	13	38	El Gavilán W	1
16	El Águila	184	39	El Cuervo	15,076

No.	Name	Area (Ha)	No.	Name	Area (Ha)
17	Ampliación Pancho Villa	930	40	Monte Verde S	17
18	Ojitos S	226	41	Santa Anita NE	1
19	El Gavilán S	39	42	La Ciénega W	1
20	Papalote de San Pedro	3	43	La Ciénega NW	36
21	San Pedro N	8	44	Nevarez	101
22	Nifay SW	54	45	Monte Verde	91
23	Pancho Villa E1	76		**Total Area**	**19,946 Ha**

Table 2. Prairie dog density estimated by the proportion of active / inactive burrows from 1994-1996 and 1997, and by counting maximum number of prairie dogs above ground in 2001 and 2004, in the JCG prairie dog complex. Towns labeled in **bold** are within the current ferret reintroduction area.

Towns	1994	1995	1996	1999	2001	2004
El Alto	**6.5**	**8.52**	**5.43**	**8.71**		
El Cuervo	**6.91**	**10.15**	**7.35**	**6.45**		
El Alto – El Cuervo	**6.41**	**9.39**	**3.93**	**9.62**		
Salto de Ojo	14.46	16.81	6.35	15.22	N.A.	N.A.
Pancho Villa	5.35	9.7	1.67	12.91	N.A.	N.A.
Tierras Prietas	9.58	17.58	6.34	15.65	N.A.	N.A.
Whole complex	**8.3**	**12.06**	**5.6**	**11.08**		

Table 3. Prairie dog density estimates from maximum counts above ground at any one time. Estimates made solely within the ferret reintroduction site.

Site	2001	2004
A	7.7	1.7
B	9.0	2.0
C	3.0	0.3
D	8.1	0.5
E		0.3
F		0.4
G		0.5
H		0.4
I		0.7
J		0.6
K		0.5
L		0.2
M		2.6
Average	**6.95**	**0.8**

PVA Model Development

Our general approach to using population viability analysis to explore the feasibility of black—footed ferret recovery in Mexico involves the following steps:

- Use the 2003 Conata Basin ferret PVA model as a basis for creating a similar model specific to the situation in Chihuahua
- Incorporate available data from Mexican ferret releases where data gaps can be filled
- Create a baseline PVA model using *VORTEX*
- Identify primary data gaps in the demography and ecology of ferrets that could be answered through differences in management/research approaches (e.g., radio-collaring)
- Conduct demographic sensitivity analyses to determine where research efforts should be concentrated to fill critical data gaps
- Incorporate catastrophes, if that is meaningful at this point.

Through this process, our hope is to guide the collection of relevant biological information and to stimulate support for ferret recovery in Mexico, both politically and financially.

Our overall goal is to establish a self-sustaining population of black-footed ferrets in Mexico. In the context of this modeling process, we have defined "self-sustaining" population to mean the following:

- A probability of extinction of less than 10% over a period of 50 years
- To establish a population that has an IUCN Red List status equivalent to "Lower Risk" for Mexico
- To establish a population that would contribute to the improvement of the IUCN status of ferrets globally to "Lower Risk"
- A mature reproducing population size of 250 in 10 years (i.e., to move from "Endangered" to "Threatened" in the IUCN Red List categories)
- A mature reproducing population size of 500 in 50 years (i.e., to move from "Endangered" to "Threatened" in the IUCN Red List categories)

VORTEX (v9.51) population models were designed to assess the viability of the reintroduced population of black-footed ferrets (*Mustela nigripes*) in the prairie dog towns of Janos, Chihuahua.. *Vortex* is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild populations. *Vortex* models population dynamics as discrete sequential events that occur according to defined probabilities. The program starts with the estimated population size present in the site and iterates through the annual life cycle events (e.g., births, deaths, dispersal, mortality). It incorporates stochastic events such as drought, and the life history events such as breeding success, sex ratio, litter size, and survival at different age classes which are determined based upon designated probabilities. Consequently, each iteration of the model gives a different result. By running the model hundreds of times, it is possible to examine the probable outcome and range of possibilities.

VORTEX does not give absolute answers, as it projects the stochastic iterations among the many input parameters used and the random processes that occur in Nature. The interpretation of the results depends on our knowledge of the biology of the species, environmental conditions that affect the species, and the possible future changes of those conditions. For a more detailed explanation of *Vortex* and its use in population viability analysis, see Lacy (1993, 2000) and Miller and Lacy (2003).

Particularly, we are interested in performing the following tasks:

- Using the available demographic data, to build a baseline model for the population in Mexico.
- Determine the sensibility of the key parameters for the population growth rate and the probability of extinction.
- Estimate the risk of extinction of the population in relation to the population size and inbreeding.
- Explore different management options, particularly supplementation with captive individuals.

Baseline Model

To build the baseline model, we used the information from data produced from Meteetse, Wyoming, Conata Basin, South Dakota and UL Bend Montana, and with the best estimates of the population parameters for Mexico. *VORTEX* model gives an annual growth rate of 51%. Although the carrying capacity was established on 500 individuals, density dependent mortality causes the population to stabilize in approximately 20 years in around 315 individuals

.

There is not enough information on reproduction and survival rates of the reintroduced population to develop a more precise model, consequently, we cannot use the model to make absolute and precise predictions about the future of the population. However, we can use the model to assess the relative response of the Mexican population to demographic changes. These changes can reflect our own uncertainty on the value of the parameters being measured in the field, or can reflect the results of human activities like habitat disturbance or management. We can use a conduct a sensitivity analysis to determine the impact of this uncertainty on the behavior of the model. With this information is possible to establish research and management priorities.

Reproductive system

Black-footed ferrets are polygamous animals in the wild.

Age of first breeding

We used one year as the age of the first breeding, as it is expected that this trait will be similar to the one observed in Conata Basin.

Maximum breeding age

Again, we considered that the maximum breeding age will be similar to that observed in Conata Baisn, so we used four years of age.

Kit production

We considered that while all females are capable of breeding, not all may be able to find a mate, therefore the percentage of adult females breeding is 90, EV in % adult females breeding: SD = 5.

Frequency of number of offspring is based from Conata Basin, although there was some discussion that at Meeteetse, the frequency of litters with '1' was higher. Genetic load was thought to be similar between Janos and Conata basin.

1 kit	12.4%
2 kits	28%
3 kits	35.7%
4 kits	19.8%
5 kits	4.1%

Males in breeding group

We considered that all (100%) adult males are on the breeding pool.

Mortality

Mortality rates were adjusted from Conata Basin.

% mortality of females between ages 0 and 1 = 35+(30*(N/K))
EV in % mortality: SD = 5
% mortality of adult females (1<=age<=4) = 40+(20*(N/K))
EV in % mortality: SD = 7
% mortality of males between ages 0 and 1 = 65+(15*(N/K))
EV in % mortality: SD = 5
% mortality of adult males (1<=age<=4) = 40+(30*(N/K))
EV in % mortality: SD = 7

EVs may be adjusted to closest values possible for binomial distribution.

Inbreeding depression

Not considered as it has not been reported in the ferret population yet, and because of the size of the town the number of ferrets would.

While the current population of black-footed ferrets comes from a reduced number of individuals, there is no evidence of inbreeding depression n the population. Inbreeding depression is potentially of great concern to black-footed ferret recovery efforts. And given that the population in Janos is not going to be limited by habitat, we decided not to consider inbreeding depression in the model, which was the decision adopted for the Conata Basin ferret model.

Catastrophes

Northwestern Mexico has been suffering recurrent droughts of variable duration up to 4 years long in the past 15 years (while the rainfall has been under average in relation to the historic mean for virtually all this period, non-drought years have had close to normal rainfall). These events reduce plant biomass production and creates synergy with overgrazing by cattle to reduce the vegetation cover on the prairie dog towns. The effects of drought worsen as consecutive years of drought take place, therefore we modeled drought as a recurrent catastrophe, where up to 4 consecutive years of drought could occour.

Initial population size

Black-footed ferrets observed during surveys have decreased notoriously as prairie dog numbers have declined, however, because of the large size of the prairie dog town the monitoring efforts cannot be effective to detect most ferrets, and continued and recent sighting indicate that some numbers are still alive on the ground. We opted for a conservative estimate of initial population of 25 individuals, which is a likely number of the surviving ferrets.

Carrying capacity

We had good data to estimate the carrying capacity of the prairie dog town, but still opted to be on the conservative side because of ongoing changes in the prairie dog population.

Home range size from adult females in the U.S.
Acres/ Adult Female / Year
Meeteetse: 135 acres /(4 pd/acre) = 1.65 pd / ha

UL Bend: 100 acreas /(8-15 pd/acre) = 3.3 pd – 6.21 pd / ha; ie. 4.8 as midpoint
Conata Basin: 70 acres /(15-30 pd acre) = 6.21 pd/ha – 12.42 pd/ha ; ie. 9 as midpoint
2.5 acres / ha

Using these values, we can establish expected home range sizes of females in Mexico based on a range of prairie dog town values. We will use the mean prairie dog town density from the last 20 years of data to estimate a carrying capacity for the population given these home range sizes.

Mean density in last 20 years is 7 pd / ha in Mexico
From graph relationship we would expect 33 ha / adult female ferret / year

- Assuming 10% overlap we would have 30 unique ha / adult female ferret / year
- Probable occupied area is 10,000 ha * 1 female ferret / 30 unique ha = carrying capacity 333 females
- Based on Conota basin results and Steven Forrest's memory sex ratio of females to males is 70 females: 30-35 males in 2003 fall Conata basin survey (Livieri pers. comm. data).
- Applying this the overall carrying capacity is 500, (10k ha @ 30 ha/female = 333 females and 166 males)

Number of iterations and years of projection

Given the current changes and predictions of change under climate change scenarios for the region (Soberón et al. 2002), it was considered that extending the predictions over a period of 50 years would have little forecasting value. 500 iterations of the baseline model were run.

Table 4. Input demographic parameters for the baseline model for VORTEX for the black-footed ferret in Mexico.

Input parameter	Value in baseline model
Reproductive system	Polygamous
Age at fist reproduction (♂/♀)	1/1
Age of breeding end	4
Maximum litter size per year	5
Productivity (1 / 2 / 3 / 4 / 5 kits)	12.4% / 28% / 35.7% / 19.8% / 4.1 %
Males in breeding group	100%
Adult reproductive females	90%
Female mortality (clase 0-1, 1+)	(35+(30*(N/K)), 40+(20*(N/K)))
Male mortality (clase 0-1, 1+)	(65+(15*(N/K)), 40+(30*(N/K)))
Inbreeding depresión	No
Catastrophes	No
Sex proportion at birth	1:1
Inicial population size	25
Carrying capacity	500
Number of iterations and proyected years	500 iterations for 50 years

Modelling results

Sensitivity analysis

The baseline model was modified and modeled independently in different scenarios, controlling the sensibility to changes of the different variables, in order to determine the critical parameters that can have a significant impact in the population size for a 50 year period. The sensitivity analysis in turn allows the identification of detailed research priorities and/or management needs focused to specific elements of the species' population biology or ecology.

In order to perform the sensitivity analysis we selected a group of six parameters that can be independently modified by a specific and proportional amount. By changing each one though a fixed range of proportional values, we are capable of directly compare the impact of constant proportional changes of each parameter in the performance of the development of each parameter in the population, such as the stochastic population growth.

Table 5. Range of values used for the Sensitivity Analysis. The values of the baseline model correspond to 100%.

	75	87.5	100	112.5	125
Mortality					
Female 0-1	26+(30*(N/K))	31+(30*(N/K))	35+(30*N/K)	39+(30*(N/K))	44+(30*(N/K))
Female 1+	30+(20*(N/K))	35+(20*(N/K))	40+(20*N/K)	45+(20*(N/K))	50+(20*(N/K))
Male 0-1	49+(15*(N/K))	57+(15*(N/K))	65+(15*N/K)	73+(15*(N/K))	81+(15*(N/K))
Male 1+	30+(20*(N/K))	35+(20*(N/K))	40+(20*N/K)	45+(20*(N/K))	50+(20*(N/K))
Kit Production					
1	9.3	10.85	12.4	13.95	15.5
4	22.9	21.4	19.8	18.3	16.7
2	21	24.5	28	31.5	35
3	42.7	39.2	35.7	32.2	28.7
% Females breeding	78.75*	67.5	90	-	-

*= PE= 0.03, remaining scenarios PE= 0.00

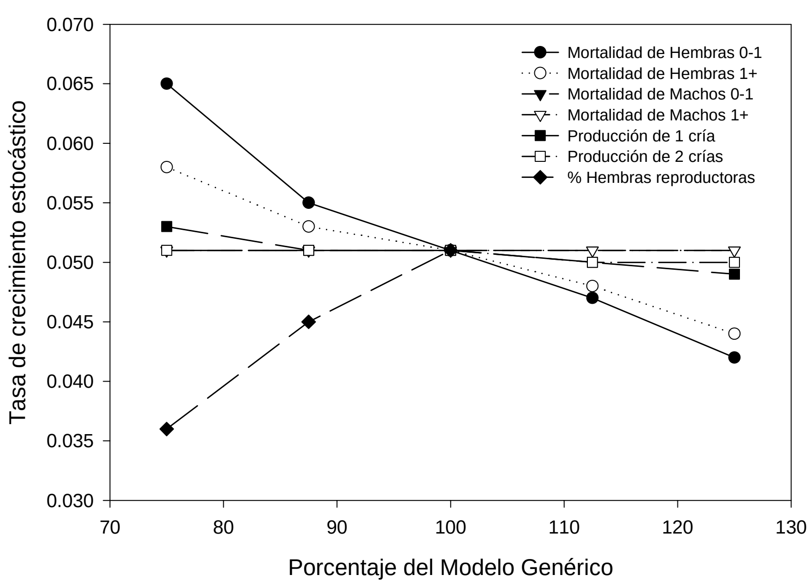


Figure 2. Demographic sensitivity analysis of the black-footed ferret population in Mexico. The graph shows the stochastic growth rate of the population for a group of models in which the specific parameters vary through a proportional range of possible biological values. The stochastic growth rate of the generic model is 0.051.

According to the results of the sensitivity analysis shown on Figure 2, our model was more sensitive to those parameters which show the greatest change in the rate of stochastic growth through the range of proportional parameters. For example, male mortality, and the percentage of females that produce 1 or 2 kits show, little change in the growth rate of the population through the range of values. In contrast, female mortality and the percentage of reproductive females show significant changes in the proportional values of the parameters. We can conclude from this analysis that our model is particularly sensitive to the mortality of juvenile females and to the proportion of reproductive females.

Risk Analysis: Population size and inbreeding

We are interested in studying the relationship between the population size of the black-footed ferret and the detrimental impacts of inbreeding.

Inbreeding affects juvenile mortality as a. fiunction of the number of lethal equivalents assuming the persistence in the population. In the absence of specific field data, we started our models with a depression severity by inbreeding defined as three lethal equivalents. This value is similar to the average obtained in a detailed study of a large number of captive mammal populations (Ralls et al., 1988).

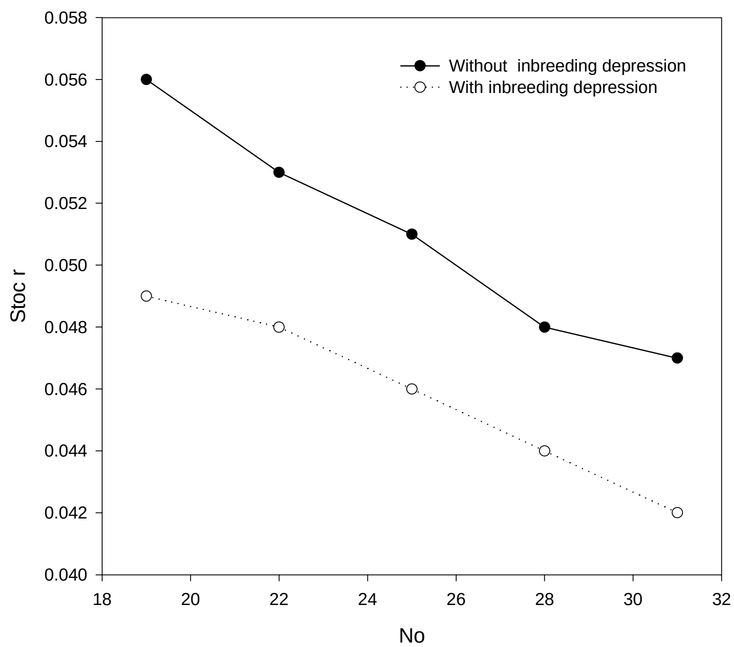


Figure 3. Risk analysis of the black-footed ferret population in Mexico. Stochastic growth rate on 50 years for a group of models in which the initial population size and the influence of inbreeding depression is changed.

We developed a series of models to analyze the viability among different population sizes, with or without inbreeding depression (Figure 3).

Impact of inbreeding depression:. The graphs shows that for all initial population sizes, the inbreeding depression is expressed as a lower stochastic growth rate, equivalent to approximately 10%.

Impact of small population sizes: The smallest populations show a higher stochastic growth rate. This is because of the strong effect of density in mortality, increasing the mortality as the population increases.

In no scenario do we find that the probability of extinction becomes greater than 0.00.

Risk Analysis II: Effect of drought on carrying capacity

To model the effect of drought in the population viability of the black-footed ferret in Mexico, several models were run, decreasing carrying capacity with a determined frequency and severity over a maximum period of four years.

Table 6. Parameters used to model six drought scenarios.

Drought	Ko and frequency	Formula to simulate changing K	stoc r	PE
1	999 - 15	999-((360*(SRAND(Y+(R*100))<0.07))+(270*(SRAND((Y-1)+(R*100))<0.07))+(180*(SRAND((Y-2)+(R*100))<0.07))+(90*(SRAND((Y-3)+(R*100))<0.07)))	0.063	0.00
2	500 - 15	500-((200*(SRAND(Y+(R*100))<0.07))+(150*(SRAND((Y-1)+(R*100))<0.07))+(100*(SRAND((Y-2)+(R*100))<0.07))+(50*(SRAND((Y-3)+(R*100))<0.07)))	0.049	0.00
3	333 - 15	333-((165*(SRAND(Y+(R*100))<0.07))+(132*(SRAND((Y-1)+(R*100))<0.07))+(99*(SRAND((Y-2)+(R*100))<0.07))+(33*(SRAND((Y-3)+(R*100))<0.07)))	0.042	0.10
4	999 - 10	999-((360*(SRAND(Y+(R*100))<0.1))+(270*(SRAND((Y-1)+(R*100))<0.1))+(180*(SRAND((Y-2)+(R*100))<0.1))+(90*(SRAND((Y-3)+(R*100))<0.1)))	0.063	0.00
5	500 - 10	500-((200*(SRAND(Y+(R*100))<0.1))+(150*(SRAND((Y-1)+(R*100))<0.1))+(100*(SRAND((Y-2)+(R*100))<0.1))+(50*(SRAND((Y-3)+(R*100))<0.1)))	0.049	0.00
6	333 - 10	333-((165*(SRAND(Y+(R*100))<0.1))+(132*(SRAND((Y-1)+(R*100))<0.1))+(99*(SRAND((Y-2)+(R*100))<0.1))+(33*(SRAND((Y-3)+(R*100))<0.1)))	0.041	0.14

In Figure 4 can be observed that drought has a reduced effect in the population model, for any of the frequencies modeled, and again, carrying capacity shows a strong effect because mortality is dependent on the carrying capacity.

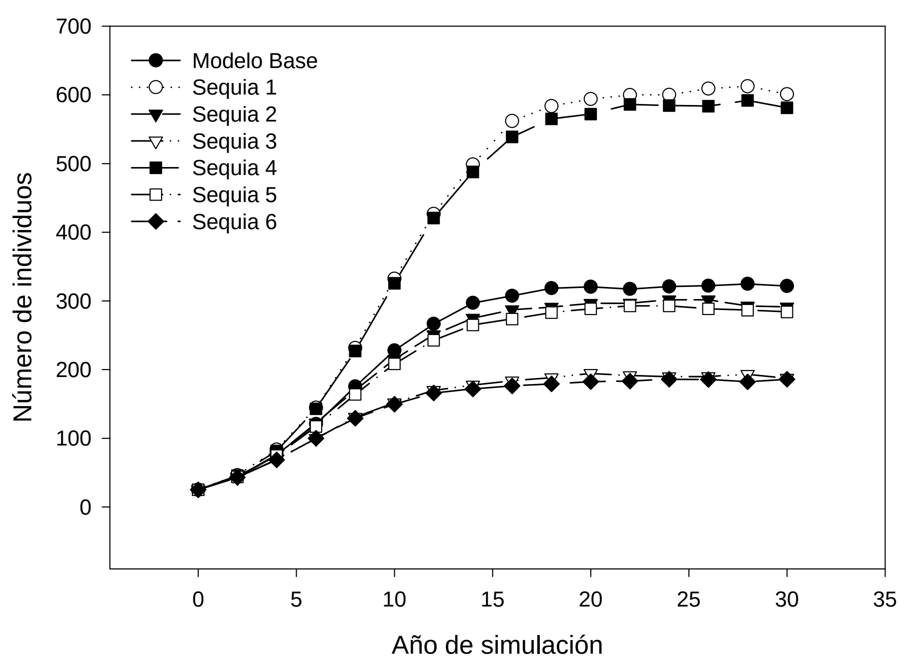


Figure 4. Risk analysis of the black-footed ferret population in Mexico. The graph shows the probability of extinction in 50 years for a group of models with varying effects of drought on the number of breeding females.

Management scenarios

Finally, the effect of supplementation with captive animals was studied. The different scenarios are shown on Table 7.

Table 7. Entry parameters used in the supplementation models for the black-footed ferret in Mexico, and stochastic growth values and extinction probability.

SUPPLE-MENTATION	Males	Females	Nº of years	From	To	Every	Stoc r	PE
1	5	5	3	1	3	1	0.051	0.00
4	5	5	10	1	10	1	0.051	0.00
5	10	10	10	1	10	1	0.051	0.00
8	25	25	10	1	10	1	0.051	0.00
9	10	0	10	1	10	1	0.051	0.00
10	0	10	10	1	10	1	0.051	0.00

None of the modeled supplementations shows an increment in the stochastic population growth rate.

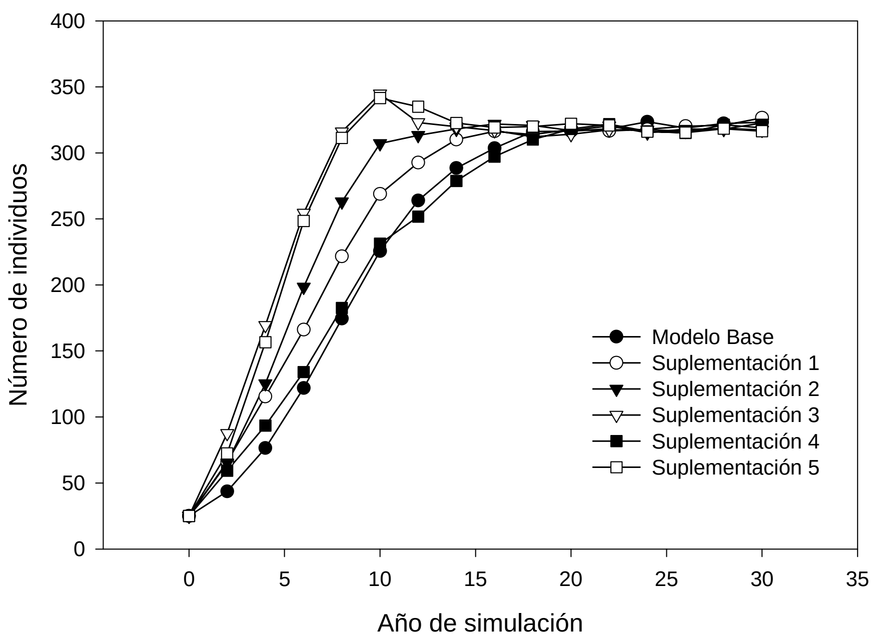


Figure 5. Risk analysis of the black-footed ferret population in Mexico. The graph shows the probability of population growth with different supplementation scenarios.

Conclusions from PVA Modeling

- The population modeled is particularly sensitive to juvenile female mortality, and percentage of reproductive females.
- The supplementation of the wild population with captive-born animals does not appear to have a significant long-term effect on the viability of the population.
- It is necessary to conduct a more detailed analysis about the viability of the black-footed ferret in Mexico with more information

Conservation Strategies

<u>Objective 1: Maintain or improve carrying capacity from 2004 levels</u>

Strategy A: Stop further habitat loss and fragmentation

1. Enforce regulations to stop habitat conversion. Report any plowing and drilling activity to Procuraduría Federal deProtección al Ambiente (PROFEPA) and Municipality, and follow up report. Universidad Nacional Autónoma de México (UNAM) and other ENGOs working in the area. Continuous.
2. Facilitate the production of the Ecological Zoning Plan of the Municipality. Funding from Comisión Nacional de Áreas Naturales Protegidas (CONANP), UNAM organizes expert's team, Municipality organizes participants. May 2005.

Strategy B: Increase prairie dog-occupied habitat and connectivity

1. Finalize agreement for purchase of grazing rights, on prairie dog town. UNAM-Szekely. April 2005
2. Determine management guidelines for conservation pasture to restore/increase prairie dogs. UNAM-Ejido (cattle was removed in 2004) June 2005. UNAM funding.
3. Determine suitable habitat to restore prairie dog towns/connectivity to maximize ferret movement and carrying capacity. UNAM. January-June 2006. Funding source needs to be identified.
4. Identify incentives for restore/increase prairie dogs (including US and NAFTA Funds). CONANP-UNAM. Second half 2005.

Strategy C: Improve range condition quality for prairie dogs

1. Organize grazing management workshop for Ejido and Ranches. INIFAP. Fall 2005.
2. Conduct studies on range condition/restoration possibilities. INIFAP-UNAM. January-December 2006. Funding source needs to be identified.
3. Identification of incentives for economic alternatives in prairie dog towns to phase cattle off. CONANP-UNAM-Ejido. Second half 2005.

Strategy D: Determine prey use and availability of non-prairie dog prey for BFF

1. Collect feces during trapping and around burrows to identify prey species and determine availability of alternative prey. UNAM. Continuous from 2005.

Objective 2: Maintain or improve survival of released and established BFF respectively.

Strategy A: Assess mortality rates of released and established BFF respectively.

1. Intensive monitoring effort. BFFRIT-UNAM. November 2005. UNAM funding.

Strategy B: Assess age-specific mortality rates of established ferrets.

Strategy C: Assess short and long-term mortality rates of released ferrets.

1. Intensive monitoring effort. BFFRIT-UNAM. November 2005. UNAM funding.
2. Releasing radio-collared ferrets in 2005. UNAM. October-December 2005. UNAM funding.

Strategy D: Determine mortality causes of released and established BFF respectively.

1. For released ferrets, release radio-collared ferrets in 2005. UNAM. October-December 2005. UNAM funding.

Strategy E: Develop a disease exposure and management strategy.

1. Develop a monitoring scheme for plague and distemper. BFFRIT-UNAM.
2. Create an reaction protocol for disease.

Objective 3: Cultivate public and institutional support for maintaining prairie dog habitat and restoring BFF

Strategy A: Develop an accepted historic status of BFF in Mexico.

Strategy B: Develop recovery plan for BFF in Mexico

Strategy C: Increase participation of government agencies in BFF recovery

Strategy D: Increase public education effort

Strategy E: Develop a sustainable funding base

International Black-Footed Ferret Recovery Workshop

Calgary, Alberta, Canada
1 – 4 April, 2005

FINAL REPORT

Section VI
Workshop Participant List

International Black-Footed Ferret Recovery Workshop
Participant List

Sam Barry
Canadian Wildlife Service
sam.barry@ec.gc.ca

Bill Bristol
Agriculture and Agri-food Canada
Prairie Farm Rehabilitation Administration
bristolb@agr.gc.ca
Ph: 306-780-8155

Juan Cornejo
Africam Safari
Mexico
jcornejo@africamsafari.com.mx

Tian Everest
Centre for Conservation Research
Calgary Zoo
tiane@calgaryzoo.ab.ca
Ph: 403-232-9391

Pat Fargey
Grassland National Park
Parks Canada
pat.fargey@pc.gc.ca
Ph: 306-298-2166

Steve Forrest
World Wildlife Fund
scforrest@earthlink.net
Ph: 406-582-0236

Maria Franke
Toronto Zoo
mfranke@torontozoo.ca
Ph: 416-392-5967

Keith Gibson
Centre for Conservation Research
Calgary Zoo
keithg@calgaryzoo.ab.ca
Ph: 403-294-7662

David Gummer
Provincial Museum of Alberta
david.gummer@gov.ab.ca
Ph: 780-453-9125

Shin-ichi Hayama
Nippon Veterinary & Animal Science University, Japan
hayam@nvau.ac.jp
81-422-31-4151

Geoff Holroyd
Canadian Wildlife Service
geoffrey.holroyd@ec.gc.ca
Ph: 780-951-8689

Rurik List
Institute of Ecology
National University of Mexico
rlist@prodigy.net.mx
Ph: 55-5- 622-9004 (wk)
722-216-6-6416 (hm)

Travis Livieri
Prairie Wildlife Research
tlivieri@prairiewildlife.org
Ph: 605-279-2380

Colleen Lynch
Population Management Center
American Zoo and Aquarium Association
clynch@lpzoo.org
Ph: 312-742-7229

Paul Marinari
US Fish & Wildlife Service
wyoweasel@hotmail.com
Ph: 307-322-5933

Sue McAdam
Saskatchewan Environment
smcadam@serm.gov.sk.ca
Ph: 306-778-8489

Phil Miller
Conservation Breeding Specialist Group
pmiller@cbsg.org
Ph: 952-997-9800

Axel Moehrenschlager
Centre for Conservation Research
Calgary Zoo
axelm@calgaryzoo.ab.ca
Ph: 403-232-7771

Akira Murayama
Tsushima Wildlife Conservation Centre,
Ministry of Environment, Japan
a-mura@minos.ocn.ne.jp
81-920-84-5577

Jesus Pacheco
Institute of Ecology
National University of Mexico
jpacheco@miranda.ecologia.unam.mx
Ph: 52-55-5-622-9004

Bob Peel
Calgary Zoo
bobp@calgaryzoo.ab.ca
Ph: 403-232-9304

Dave Poll
Parks Canada
dave.poll@pc.gc.ca

Kent Prior
Parks Canada
kent.prior@pc.gc.ca

Lindsay Rodger
Parks Canada
Lindsay.Rodger@pc.gc.ca
Ph: (819) 953-6575

Robert Sissons
Grasslands National Park
Parks Canada
robert.sissons@pc.gc.ca
Ph: 306-298-2119

Kathy Traylor-Holzer
Conservation Breeding Specialist Group
kathy@cbsg.org
Ph: 952-997-9800

Joanne Tuckwell
Parks Canada
joanne.tuckwell@pc.gc.ca

Lorne Veitch
Saskatchewan Agriculture
Lands Branch
lveitch@agr.gov.sk.ca
Ph: 306-778-8300

Doug Whiteside
Animal Health Centre
Calgary Zoo
dougw@calgaryzoo.ab.ca
Ph: 403-232-9390

International Black-Footed Ferret Recovery Workshop

Calgary, Alberta, Canada
1 – 4 April, 2005

FINAL REPORT

Section VII
Appendices

Appendix 1:
Black-Footed Ferret and Black-Tailed Prairie Dog Draft Communications Plan

Draft Plan Date: 4 April 2005
Draft Authors: Geoff Holroyd, Parks Canada
Maria Franke, Toronto Zoo

Issues

The black-footed ferret was one of the most noteworthy species in Canada. The Canadian population of black-footed ferrets disappeared from Alberta and Saskatchewan in the early 20th century. Moreover researchers are still unsure of the reasons for their dramatic decline and disappearance in Canada.

The black-footed ferret was an integral part of the prairie environment. The ferret lived in prairie dog colonies and may have existed in areas of Richardson ground squirrels.

The native grassland habitat occupied by prairie dogs exists on public and private land in southern Saskatchewan. As such, cooperative land holder stewardship initiatives are required to re-introduce this species. An enhanced communications strategy is required to further the relationship between the public (particularly land holders) and black-footed ferret conservation. Direct benefits to black-footed ferret conservation are anticipated through enhanced proactive dialogue.

Producer concerns include expanding black-tailed prairie dog populations and SAR act will inhibit their livelihoods. They may also be concerned that black-footed ferrets eat prairie dogs and plague and prairie dogs seem to go together. Also some will worry that ferrets might eat other things: livestock, pets, and other SAR.

Prairie dogs have limited distribution in Canada. In Grasslands National Park (GNP), local ranchers tend to see them as pest animals, looking at them with disfavour. However, there has been little control on prairie dog populations due to the fact that there are only two privately managed ranches that have prairie dog towns on their property. The expansion of prairie dog towns may increase local concerns. The prairie dog is protected within the park boundaries and is looked at as a keystone species that promotes tourism opportunities.

With the release of an extirpated species, the black-footed ferret, concerns from local stakeholders may stem from perceived restrictions due to the SARA. Local ranchers may also view releasing ferrets in GNP as favourable since ferrets feed largely on prairie dogs. Stakeholders and visitors opinions will need to be heard as decisions reflect their concerns.

Communication Goals

- To increase understanding, awareness, and appreciation about the status of the Black-footed Ferret in Canada, the wildlife that the ferret depends upon, and the plight of grassland ecosystems in general.
- To build support for Black-footed Ferret recovery efforts and grassland habitat protection initiatives.
- To establish the Black-footed Ferret as a symbol of grasslands conservation in Canada.

- To honour and increase the profile and pride of voluntary land stewards who support prairie dogs and ground squirrels that support ferrets.

Key Messages

1. The Black-footed Ferret was declared extirpated in 19xx by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Few other species on the prairies that are extirpated have an opportunity to be reintroduced.
2. Black-footed ferrets primary food source is black-tailed prairie dogs and reintroduction of ferrets will invariably impact prairie dog populations. It is unlikely that the small number of ferrets released per year into GNP would cause a rapid and irreversible decline in numbers of prairie dogs. The black-footed ferret needs healthy populations of all prairie dogs species if it is to be reintroduced. Research programs monitoring the impact of the prairie dogs would be imperative and would allow for the removal of ferrets if inordinate impacts to prairie dog populations were detected.
3. Eighty percent of Canada's grasslands are gone. The disappearance of the black-footed ferret was a signal that Canada's overall ecosystem was in trouble. Our natural heritage and connection to the land is weakened as a result of this loss.
4. Grasslands National Park is home to many rare and threatened species, including the black-tailed prairie dog. Expanding prairie dog habitat could be a key factor in successfully establishing black-footed ferret populations in GNP. This keystone species is an important part of prairie ecosystems by helping to regulate changing plant and animal species composition, diversity and production.
5. A diverse team of people including scientists, land holders, land managers, and policy makers are working together to reintroduce the black-footed ferret.
6. Many land holders have played a major part in the recovery of other prairie species and continue to manage grassland systems with care. This history of conservation has been expanded with efforts to reintroduce the black-footed ferret.
7. Canadians who value our natural heritage believe the voluntary efforts of land holders are worthy of celebration and praise.
8. The black-footed ferret is a species of international concern. Efforts to save this species from extinction require the cooperation of many individuals and communities throughout its range in Canada, U.S., and Mexico.
9. SARA info
10. There is a presence of sylvatic plague (*Yersinia pestis*) outbreaks in 66% of the prairie dog's historic range in the United States. Historically, plague has been recorded in dogs and cats in the surrounding areas of GNP but currently, it has not been detected in prairie dog populations in Saskatchewan. Prairie dog and canine populations within GNP will be monitored for plague outbreaks, which if present, would effectively eliminate any possibility of ferret recovery by leading to the death of 99% of the affected colonies. Risk of plague to the visitors and locals is extremely low however if detected in prairie dog populations within GNP, precautions would need to be taken and issues addressed
11. There are potential concerns about black-footed ferret reintroductions affecting other threatened and endangered species within the park. While this has not been an issue in release sites in the United States and Mexico, Park staff will need to monitor and address concerns.
12. Parks Canada National Message – National parks play many roles: protection of biological and ecological processes and diversity, centres for education and research, recreation, spiritual renewal, cultural and historic protection and aesthetic benefits. Parks have value in all these realms.
13. Saskatchewan – Agriculture, Food and Rural Revitalization (Crown Lands & Pastures) Mandate: To promote the sustainable and integrated use of Crown land while providing opportunities for diversification and economic growth
14. Input the perspectives of other organizations. People to email Maria.

15. Additional Messages
    - Why introduce black-footed ferrets
    - Why black-tailed prairie dogs are important
    - June workshop and direction forward, planning strategy
    - How you can be involved e.g more information, distribution lists, be informed about other communication activities etc.

Target Audiences

- Directly affected private land managers
- National Park neighbours - especially regional ranchers, mixed farmers, rural municipality representatives, regional school groups, and Val Marie residents
- Community media (weekly newspapers, radio, television, etc.) in the southern part of Saskatchewan.
- Visitors to black-footed ferret country – on-site and virtual
- Land holders and community leaders in Black-footed Ferret range
- Resource users, land management agencies, Aboriginals, municipalities, Environmental Non-Government Organization's across Canada.
- Children in prairie schools, youth groups, and students throughout Canada learning endangered species curriculum.
- Regional tourists
- Public in large prairie cities.
- National media (print, broadcast, electronic, etc.).
- Public and media in range of black-footed ferrets (the United States and Mexico) in cooperation with the international BFF communication committee.
- US Fish and Wildlife Service and other US and Mexican partners.
- Zoo Audiences
- Regional and national environmental NGOs
- Internal Priority Audiences:
  Parks Canada Staff - including front line workers, asset staff, field workers, etc; **PFRA; Pasture Mangers, Patron Committee, Regional Land Manager, Head of Comm Pastures,**
  SAFRR - Pasture Manager, Adv. Comm, Regional Pasture Manager, Manager Sask Pasture Program, Director of Lands Branch (Minister)
  Saskatchewan Environment - Ecological Assessment Unit Acting Manager - Kevin Murphy; Ecosystem Management Section - Nancy Cherny; Resource Stewardship Branch - Hugh Hunt
  Senior Managers - including Superintendent, Director General Western and Northern Canada, PC-NO, CWS PNR Director,
  Politicians: Minister, MLA, MP
- **Health Care Providers -** including volunteer ambulance staff, directors, local health region authorities, practitioners and visitors and researchers to improve awareness of plague

Strategic Considerations

1. We must strive to communicate and educate through several methods to our target audiences. Programs should foster a dialogue between team members and the public- particularly among landholders.
2. Emphasize listening to landholders rather than 'educating' landowners
3. The black-footed ferret has considerable intrinsic appeal. The strong emotional responses it engenders ought to be used strategically in communication programs.
4. The fossorial mammals, the prey of the ferret, are often viewed negatively, but striking a balance between these integral roles in prairie ecosystems must be promoted.
5. Effort should be made to build awareness using strong visuals such as photos, video clips. Non-conventional means such as art, poetry, and music should also be employed to build a broad-spectrum communication campaign.
6. The media campaign, when possible, should be structured to focus on positive, non-controversial elements (such as land holder co-operation), rather than on confrontational or negative stories.
7. Many agencies, organizations, and groups are involved with the communication of black-footed ferret issues. As a team we should coordinate our efforts to maximize our communication efficiency while at the same time encourage all team members to communicate frequently through relevant media. Media releases that involve other partners should be reviewed by them in advance. Articles should be shared with the team in a timely fashion.
8. Communications should aim for a more personalized approach. Because the black-footed ferret lacks identity to many Canadians, its profile should be raised by bridging this gap in awareness with familiar metaphors and examples to which the audience can relate. (i.e.: personal efforts resulting in grassland conservation)
9. When profiled we should exercise restraint with scientific and bureaucratic rhetoric as it tends to disengage and disassociate the public and subject. Phrase important issues in a way that makes then palatable to those that receive it. Use plain and active language.

Communications Goals

The communication goals resulting from this plan include:

Build support for concept of reintroductions.

A. Through communications, the park will increase understanding, appreciation and support for ***prairie conservation*** by visitors, ranchers, mixed-farmers, private and public managers.
B. We will also increase understanding, appreciation and support for the unique role of GNP within the larger prairie conservation context and build support for concept reintroductions.
C. We will increase understanding, appreciation and support for the unique role of black-tailed prairie dogs and black-footed ferrets, in the prairie ecosystem.
D. We will enable visitors to act safely on the prairie landscape, and demonstrate appropriate behaviour regarding unique and threatened species.
E. We will build a bridge whereby the public can access accurate and thorough information on black-footed ferrets and black-tailed prairie dogs, including biology, behaviour and safety.
F. We will work with and support the other organisations involved in the recovery efforts of black-footed ferrets and black-tailed prairie dogs, including federal, provincial, international and zoological institutions.
G. We will support the involvement of local health stakeholders and provincial environment departments regarding black-footed ferret and black-tailed prairie dog safety and protection.
H. We will be trusted and understood by our neighbours as we advance management actions.

I. We will be understood by conservation and other organisations as we advance management actions.
J. We will enable more Canadians to better ***connect*** with their personal, cultural and natural stories. We value their involvement.

General Activities

- Develop and distribute a press kit to media in the region including postcards, brochures, print ready photos, B-roll video, feature article, current news release, and available contacts.
- Continue to foster, strengthen, and feed local media contacts. Learn to recognize and act when story ideas surface.
- Profile model land stewards as examples of excellence and conservation heroes.
- Highlight the presentations of existing conservation awards for outstanding stewardship.
- Develop a media protocol for team members who may find themselves in a communications setting including media-friendly briefings and notes on style and presentation.
- Identify list of venues, conferences, workshops, public events, etc. for display and distribution of Black-footed Ferret information. This could be linked to new habitat stewardship display and plans.
- Continue with zoological (Toronto Zoo) education outreach programs and solicit other institutions to come on board.
- Develop a seasonal communications campaign with timelines for news releases that highlight diverse and relevant aspects of the Black-footed Ferret's life cycle. (i.e.: spring activit, summer productivity, fall numbers, winter locations, etc.)

Specific Activities

Public/Schools/Media

- Escalate production of articles directed to community newspapers in prairie Canada. Modify and cycle these features to additional outlets, if appropriate.
- Solicit interest among trusted nature writers, documentary film makers, etc. to initiate the production of Black-footed Ferret stories - have team members prepared to offer logistical or other support during production.
- Investigate provincial school curriculum and ensure that available resources are accessible to teachers and students. If resources are not being used effectively create a user friendly package in cooperation with our out reach specialists. Currently, Toronto Zoo is doing this in Ontario.
- Postcards should be produced as part of a series on endangered wildlife. The free postcards would be available to Canadians and available in Spanish for international distribution.
- Investigate the feasibility of producing a 'Hinterland's Who's who' piece available to air as a Public Service Announcement.
- Develop international distribution plan for materials with international partners.
- Develop a model website that enhances web information and networking to profile theteam, and its projects.
- Contribute to public and internal-agency magazines.
- Researchers should publicize their major findings in a non-technical manner in a variety of media for people who don't read scientific journals.
- Continue to foster outreach programs to schools and community organizations. Currently being done by Toronto Zoo in Ontario. Use their feedback (i.e.: children's art, etc.) as an opportunistic communication tool.

Land Holders

- Develop a protocol for team members when interacting with the public- particularly land holders. Interactions with land holders should aim to become increasingly regular and positive.
- Advance newspaper features by profiling land stewards.
- Continue celebrating model land holders with a yard sign, pin, and annual newsletter in recognition and respect of their valuable contributions.
- Develop opportunities for land holders to strengthen stewardship values.
- Seek on the ground expertise through a land holder survey to determine where knowledge gaps exist and what land holders think can be done to help Black-footed Ferrets.
- When opportunities arise, team members ought to consider lending a helping hand to land holders. By spending a few hours working alongside land stewards (i.e: branding cattle, mending fences, etc.), members can do more to build and solidify relationships than extensive media campaigns.

Evaluation

- Determine the extent and tone of media coverage of the Black-footed Ferret and related prairie conservation stories.
- Quantify the number of hits on web sites.
- Follow the statistics and trends on land holder involvement and conservation activities.
- Follow the demand and inquiries for information from various team members.
- Determine the feedback from public displays and conferences.
- Determine the effectiveness of communication materials though pre and post use evaluation.

Contacts

For More Information contact:
Pat Fargey/ Robert Sissons, Co-Chair, Black-footed Ferret Recovery Team
Grassland National Park,
Val Marie, SK
phone ; FAX ; Email: <@.gc.ca >

Colin Schmidt - Client Services Supervisor, GN

Background

AN ECOLOGICAL REVIEW OF THE BLACK-FOOTED FERRET WITH SPECIAL REFERENCE TO PRAIRIE DOG HABITAT IN SOUTHWESTERN SASKATCHEWAN

Introduction

The black-footed ferret is an intermediate-sized member of the weasel family Mustelidae. The original range distribution of ferrets was the Great Plains and inter-mountain region wherever black-tailed, white-tailed, and Gunnison's (*Cynomys ludovicianus, C. leucurus, C. gunnisoni*) occurred. Adult ferrets weigh 0.75 to 1 kg and have a total length of about 0.5 m. Black-footed ferret fur is a yellowish buff with black legs, a black- tipped tail, and a black face mask across the eyes. Ferrets breed in March and early April and may first breed at about 11 months of age (Forrest et al. 1985). The gestation period is 42-45 days. Young are born in May and emerge from natal burrows in July. Litter size is typically 3 to 4 young (average 3.3-3.5 Hillman and Clark 1980, Forrest et al. 1988), but may range from 1-5. At Meeteetse, Wyoming, the site of the last known wild ferret population the sex ratio of adult ferrets was 1 male:2.2 females, and the ratio of young to adults was 1.95:1. Adults were territorial and showed strong fidelity to home ranges from one year to the next. Intercolony movements were made primarily in fall by juvenile males. Annual estimated survival ranged from 24 to 47% (Forrest et al. 1988). Predation and fall dispersal of juveniles appeared to play a significant role in the annual loss of ferrets. Greater than 40% juvenile survival is required for a sustainable population (Randy Matchett, US Fish and Wildlife Service biologist, pers. commun.).

The black-footed ferret (*Mustela nigripes*) is an obligate predator of prairie dogs (*Cynomys* spp.). On the Great Plains, the ferret is associated almost exclusively with the black-tailed prairie dog (Henderson et al. 1974). Ferrets live in prairie dog colonies using prairie dog burrows as den sites for rearing of young and as shelter for daily resting sites to avoid climatic extremes. Prairie dog burrows also serve as escape cover to evade larger mammalian and avian predators. In addition to the physical habitat features provided by prairie dog colonies, prairie dogs are the major prey item in the black-footed ferret diet (Sheets et al. 1969, Sheets et al. 1972, Henderson et al. 1974, Campbell et al. 1987). The ferret is a highly specialized predator of prairie dogs. At approximately 1 kg, the ferret has a similar mass and size of prairie dogs, and is capable of moving freely through prairie dog burrow systems and killing prairie dogs within their burrows. Prairie dogs comprise nearly all of the ferret diet (Henderson et al 1974, Forrest et al. 1985). Such a tight relationship between a predator and its prey suggests a long-term association of the these two species (Hillman and Clark 1980), and has produced an ecological situation where ferrets are not capable of sustaining viable populations in the absence of prairie dogs (Henderson et al. 1974), or even at some critical low density and distribution of prairie dogs (less than 4,500 ha of prairie dogs or colonies located more than 1.5 km apart).

There are at least two levels of association of ferrets with prairie dogs. 1) On a large scale, there needs to be within a given area adequate numbers and distribution of prairie dog colonies to sustain a viable ferret population. Without an adequate number and distribution of prairie dog colonies, ferret populations will ultimately go extinct. The current estimate of area occupied by black-tailed prairie dogs necessary to provide for a viable ferret population is about 4,500 ha. 2) Within a prairie dog colony, there needs to be adequate space for a sufficient number of prairie dogs and burrow systems to allow individual ferrets to live and reproduce. If a colony is not large enough to meet the year-long needs of a ferret, then there must be adjacent nearby colonies that can collectively provide for the requisite needs of ferrets. The minimum suitable size for a black-tailed prairie dog colony to sustain a ferret family on an annual basis is about 40 ha (Henderson et al. 1974, Hillman et al. 1979). If smaller prairie dog colonies are to be used collectively by ferrets to obtain sufficient habitat to live and reproduce on a year long basis, the colonies need to be within 1.5 km of each other (Randy Matchett, US Fish and Wildlife Service Biologist, pers. commun.). However, inter-colony travel through areas with no burrows for escape cover can result in increased predation mortality of ferrets.

Prairie dog control (Koford 1958) and the introduction of sylvatic plague during the 20^{th} century (Cully 1989) resulted in extirpation of all known black-footed ferret populations throughout its range distribution by 1986 (Clark 1989), and for several years all known ferrets were held in captivity (Russell et al. 1994). Prior to this, a declining ferret population associated with black-tailed prairie dogs was studied in South Dakota in the 1960s and 1970s, a remnant ferret population was discovered and briefly studied in a large black-tailed prairie dog colony the late 1970s in Montana, and another declining population associated with white-tailed prairie dogs was studied in Wyoming during the 1980s. Aside from information gained from studying these populations, most accounts of ferrets were anecdotal observations or specimens primarily collected following prairie dog control efforts (Clark 1989). Since 1991 ferrets have been reintroduced to 11 sites in 6 states and Mexico. To date, only 1 site in South Dakota and 1 site in Wyoming appear to have naturally sustainable populations while the reintroduction at the other 9 sites have either failed to produce sustainable populations or it is too early in the reintroduction effort to determine the likelihood of success.

This report summarizes much of the information on the life history and ecology of the black-footed ferret as it relates to Grasslands National Park as a potential black-footed ferret reintroduction site.

Overview Of Ferrets And Prairie Dogs In Saskatchewan

The northern distributional limits of the black-tailed prairie dog includes southwestern Saskatchewan and Grasslands National Park. Although prairie dogs were not reported in Saskatchewan until 1927 (Soper 1938), it is likely that they were present in southwestern Saskatchewan prior to settlement (Anderson et al 1986). The original prairie dog range distribution in Saskatchewan was considered to be the Climax and Val Marie areas along the lower portions of Frenchman River (Soper 1938), but Coues (1978) reported black-tailed prairie dogs to be common between the Milk River and the Canadian border and that in this area they were restricted to primarily to drainage bottomlands such as along the Frenchman River. Active black-tailed prairie dog colonies or visible remnants of abandoned colonies are found in north-central Montana west of Cutbank, north of Shelby, west of Galata, north of Chester, west of Fresno Reservoir on the Milk River, north of Harlem, north of Malta, north of Hinsdale, west of Opheim, and west of Wolf Point. This would indicate that there was at least potential for a broad zone of prairie dog contact with southern Alberta and Saskatchewan. The colony first reported by Soper (1938) was known to have actually started at a ranch headquarter in 1922 along the Frenchman River about 10 km northwest of Val Marie (49^{o} 19'). This would suggest that at least one other colony was in the area to provide the dispersing prairie dogs. Also in 1938, there were two more colonies reported along the Montana border that were not investigated (Soper 1938). Soper (1938) also received a report of a dispersing prairie dog killed over 16 km from a known colony which would probably indicate that there were other closer unknown colonies. Later five more prairie dog colonies were reported in the Frenchman River valley bottoms within 10 km of the Montana border (Soper 1944). Banfield (1974) reported 11 prairie dog colonies in the Frenchman River area in 1958. By 1973, 16 colonies totaling 504 ha of prairie dog occupied land were documented in the Val Marie area along the Frenchman River (Scheelhaase 1973). An inventory of this prairie dog complex during the mid-1990s found 25 colonies and 938 ha of prairie dog occupied land (Grasslands National Park Files). Since 1998, the area occupied by prairie dogs has remained relatively stable ranging from 1,031 to 1,047 ha (Rodger et al. 2004). In 2002, colony sizes ranged from 1 to 187 ha with the average colony size being 41.8 ha. Two additional small colonies (2 and

20 ha) were located outside of the Park on government grazing land. Within the area originally surveyed by Scheelhaase (1973) the number of colonies and area occupied by prairie dogs appears to have about doubled in three decades. This can be attributed in part to prairie dogs within Canada being protected from un-licensed killing since 1981 (Rodger et al. 2004), and establishment of Grasslands National Park.

Between 1924 and 1937, there were 17 black-footed ferret specimens collected in Saskatchewan, plus an additional 3 undated specimens with little attached information (Anderson et al. 1986). The 1937 specimen was the last official record of a black-footed ferret in Saskatchewan. The majority of the Saskatchewan ferret specimens came from within or adjacent to the known distributional range of prairie dogs in Saskatchewan (Anderson et al. 1986). However, four specimens were collected considerably outside of the known prairie dog distributional range. These ferret specimens may represent dispersing individuals or suggest that there may have been additional unrecorded prairie dog colonies (Anderson et al. 1986). It might also be possible that some ferrets in Saskatchewan were association with Richardson's ground squirrels (*Spermophilus richardsonii*) colonies (Laing and Holroyd 1989). The number of ferret specimens collected in the early 1900s in Saskatchewan was considerably greater than the number of ferret specimens recorded in Phillips County, Montana (2) during the same time period immediately south of the Saskatchewan prairie dog range distribution. Although number of ferrets collected does not necessarily measure ferret abundance, it would suggest that black-footed ferrets in southwestern Saskatchewan were probably as abundant as ferrets in north-central Montana where prairie dogs likely occupied 8% or more of the landscape prior to government poisoning campaigns (Knowles et al. 2002).

Since 1937, there have been many anecdotal accounts of ferrets in Saskatchewan. Between, 1967 and 1988 there were 17 reports of ferrets observations in southern Saskatchewan, Alberta and Manitoba, but only one of these was near a black-tailed prairie dog colony and many of the observations were far removed from the range of the prairie dog (Laing and Holroyd 1989). None of these observations were confirmed nor have they led to the discovery of an isolated ferret population (Laing and Holroyd 1989). The most likely explanation for these anecdotal observations is mistaken identity of the long-tail weasel (*Mustela frenata*). The black-footed ferret in Canada was classified in 1978 as extirpated (Rodger et al 2004). However, based on the specimen record established between 1924 and 1937, it is clear that the prairie dog colonies along the Frenchman River in Grasslands National Park were once inhabited by black-footed ferrets at the time of settlement, but these ferrets were unable to survive subsequent intensive prairie dog control efforts through much of the 20th century. This scenario was repeated across the range of the black-footed ferret on the Great Plains and inter-mountain region until all known populations were lost by 1986 (Clark 1989).

Black-Footed Ferret Habitat

The need to define black-footed ferret habitat was recognized as early as 1973 during the first black-footed ferret/prairie dog workshop (Hillman and Linder 1973). In 1978, the black-footed ferret recovery team recommended research to identify components of prairie dog colonies needed to support black-footed ferrets. By the 1980s, there were estimates of the minimum size prairie dog complex required to sustain a viable black-footed ferret population (Forrest et al. 1985, Groves and Clark 1986). Houston et al. (1986) developed a habitat suitability model based on five habitat variables. These variables were frequency distribution of prairie dog colony sizes, total area of all colonies, burrow opening density, intercolony distance, and prairie dog density. They thought these variables adequately described the cover and food requirements for ferrets. Although total prairie dog occupied area in the model was scaled from 1 to 10,000 ha, they stated larger prairie dog complexes would be even more suitable for ferrets. Their recommendation for ferret reintroduction was to use prairie dog colony complexes larger than Meeteetse, Wyoming (2,995 ha). However, in reality very few such large prairie dog complexes exist (Rand Matchett, US Fish and Wildlife Service, pers. commun.).

Not all prairie dog colonies necessarily represent habitat for prairie dog associated species. Use of prairie dog colonies by some prairie dog associated species such as the burrowing owl (*Athene cuniculus*) and mountain plover (*Charadrius montanus*) is influenced by topographic setting, vegetation, and size and distribution of colonies. For example, with respect to topography and vegetation, prairie dogs are capable of utilizing sites that are not suitable for mountain plovers i.e. prairie dogs are more broadly adapted to topography and vegetation than mountain plovers. Colony size and distribution of colonies is critical to some associated species. For example, small colonies receive little use by mountain plovers because there is not enough suitable habitat to provide nesting and brood rearing habitat to successfully raise a brood. Repeated observations of several associated species over many years has shown that the average size of prairie dog colony used is consistently greater than the average colony size for a colony complex. The limited data for wild ferret populations show the same trend (Henderson et al. 1974, Forrest et al. 1985). Equally critical for associated species, there needs to be a sufficient number of prairie dog colonies that are reasonably close together to maintain viable populations. For example, it is very unusual to find mountain plovers in Montana in areas with isolated or only scattered prairie dog colonies. These concepts of the need for large and closely spaced prairie dog colonies probably apply to black-footed ferrets as well and probably are even more critical because the ferret is totally dependent on prairie dogs.

The relationship of black-footed ferrets with vegetation and topography have not been studied directly. This is probably because ferret populations have been small and critically endangered at the time of discovery, and conservation concerns have been a higher priority. In addition, prairie dog colonies themselves have been generally considered as habitat for ferrets. The ferret specimen record shows that black footed ferrets were originally widely distributed nearly throughout the entire range distributions of the black-tailed, white-tailed and Gunnison's prairie dogs. Ferret specimen records have come from 120 of about 500 counties within this range distribution (Forrest et al. 1985). Within this vast geographic area, prairie dog colonies occur in a wide range of grassland, shrub/grassland and shrub habitats, and in a variety of topographic settings. The correspondingly wide distributional range of ferrets would suggest that most sites inhabited by prairie dogs would also be suitable for ferrets, i.e. prairie dogs are not more broadly adapted to vegetation and topography than ferrets. It would also suggest that structural features of prairie dog colonies (i.e. topography, vegetation height, number of burrow entrances) are more important that plant species composition.

Black-tailed prairie dogs typically, occupy shrub/grassland and grassland habitats (Koford 1958). Sites selected by prairie dogs within these habitats are generally broad, relatively level and with low growing or sparse vegetation. Collins and Lichvar (1986) inventoried vegetation on white-tailed prairie dog colonies at the Meeteetse ferret site and four other historic ferret sites in Wyoming. They found that plant species composition varied greatly between sites (shrub, shrub/grassland, grassland), but a common feature of all sites was low growing vegetation and level to gently rolling topography. Hillman et al. (1979) stated that 35% of the prairie dog colonies in their ferret study area in Mellette County, SD were along drainages, 35% were in upland prairie, 23% were on "flats" and 7% were on ridges in badland areas. Hillman et al. (1979) reported that ferrets occupied prairie dog colonies in all four topographic settings in proportion similar to their availability. All prairie dog colonies in the Mellette County ferret site were in prairie grasslands. A recent aerial survey of southeastern Montana found that about two-thirds of 1,790 black-tailed prairie dog colonies were located in valley bottomlands, about a quarter of the colonies were located in rolling upland prairie, and the remainder of the colonies were located on level well defined ridges. Prairie dog colonies on Grasslands National Park occur within shrub/grassland and grassland habitats with low growing vegetation, and in broad valley bottomlands of the Frenchman River and its tributaries (Rodger et al. 2004). Such prairie dog colonies would be suitable habitat for ferrets based on vegetation and topography if sufficiently large enough areas were occupied by prairie dogs. Frequently black-tailed prairie dogs are associated with sites intensively grazed by livestock (Koford 1958, Knowles 1986, Licht an Sanchez 1993) suggesting that black-tailed prairie dogs and their associated species may have historically had an association with bison and areas of intensive grazing (Koford 1958). Although

the number of prairie dog colonies and area occupied by prairie dogs in Grasslands National Park appear to have reached a stable equilibrium, the introduction of large grazing ungulates to this grassland ecosystem would result in a higher equilibrium value for prairie dog abundance.
Probably the two most important habitat features for ferrets within a prairie dog colony are the prairie dog burrow systems (burrow density) and the prairie dogs inhabiting those burrows (prairie dog density). The density of prairie dog burrow openings and the number of prairie dogs living in the burrows have been recognized as critical components of ferret habitat (Biggins et al. 1989). Forrest et al. (1985) determined white-tailed prairie dog burrow densities at 21 nightly black-footed use areas at Meeteetse, and burrow densities within these polygons ranged from 10 to 91 burrows per ha. However, only one of these sites had less than 35 burrows per ha. Prairie dog densities at Meeteetse ranged from about 2.5 to 9.5 prairie dogs per ha (Fagerstone and Biggins 1986). Henderson et al (1974) reported 1,200 active burrows on a 121-ha colony (9.9 burrows per ha) and 167 active burrow on a 16-ha colony (10.5 burrows per ha) used by ferrets in Mellette County, South Dakota. Both of these prairie dog colonies were in steep decline at the time of the study and went to extinction (presumably poisoning). These burrow densities should not be considered representative of black-tailed prairie dogs. More typical black-tailed prairie dog burrow densities on the Great Plains would be from 67 to 136 burrows per ha (Koford 1958, Tileston and Lechleitner 1966, O'Meilia 1982). Peak late spring/early summer black-tailed prairie dog densities within active colonies have been reported to be 12 to 67 prairie dogs per ha (Koford 1958 Davis 1966), but are more typically between 16 to 30 per ha (Tileston and Lechleitner 1966, O'Melia 1982). Overall density of prairie dogs in 1998 at the Masefield Pasture prairie dog colony adjacent to Grasslands National Park was 35.6 prairie dog per ha (Waterman 1998). This compares favorably with reported prairie dog density elsewhere. Variation in prairie dog density and burrow density in colonies across the Great Plains may be a result of variation in site productivity as determined by precipitation, soils and vegetation. Presumably, ferret density at prairie dog colonies would be indirectly effected by these factors since they influence prairie dog density.

Prairie dog colonies occur as patches of suitable ferret habitat on the landscape with colonies generally clumped in distribution as complexes of colonies (Forrest et al. 1985, Clark et al. 1987). Within a prairie dog colony complex, colonies range in size from small to large based on time since colonization, topography, vegetation, and other factors such as past control efforts. Within a colony complex, smaller colonies are generally more common than larger colonies, but the majority of prairie dog occupied land is accounted for by the larger colonies. Prior to settlement, this scenario may have been different with few small colonies and many closely spaced large colonies (Flath and Clark 1986, Clark et al. 1986, Knowles et al. 2002). The number, size and distribution of prairie dog colonies will determine if ferrets are able to maintain a viable population, and dictates extinction risks. The loss of most ferret populations were due to deterministic extinction where long-term loss of a critical habitat component (prairie dog colonies) led to negative population growth through increased mortality and decreased natality. Small relict populations such as found at Mellette County, South Dakota, Ekalaka, Montana, and Meeteetse, Wyoming were subjected to both demographic and environmental stochastic risks. When populations are small, random variation among individuals can lead to negative population growth long enough for a population to go extinct. For example, at the UL Bend National Wildlife Refuge ferret reintroduction site, following three years of no ferret releases (2000-2002) the ferret population consisted of all female and no male ferrets (Randy Matchett, US Fish and Wildlife Service, pers. commun.). Stochastic environmental effects include both chronic (e.g. small and widely spaced prairie dog colonies) and catastrophic (e.g poisoning = Mellette & Ekalaka, disease = Meeteetse) which can lead to increased mortality or decreased natality long enough to produce extinction. In small populations there are also genetic risks where loss of genetic diversity can contribute to extinction (Rieman and McIntyre 1993). Ferret reintroduction efforts must first correct deterministic risks and then overcome stochastic and genetic risks to be successful.

There have been several attempts to address extinction risks for ferrets and determine minimal viable population levels. Stromberg and Rayburn (1983) determined the energy requirements of female ferrets with young and concluded that a ferret family requires about 474-1,421 black-tailed prairie dogs on an annual basis. Using typical prairie dog densities found in black-tailed and white-tailed prairie dog colonies, they concluded that 37-95 ha of active black-tailed prairie dog colony, and 167-355 ha of active white tailed prairie dogs are required to support a ferret family for a year. Forrest et al. (1985) state that a minimum of 57 ha of white-tailed prairie dogs at Meeteetse were required to support a female ferret based on observed ferret density and their use of prairie dog colonies. They thought that their estimate of minimum size prairie dog colony needed to support a ferret family was lower than the Stromberg and Rayburn (1982) estimate because prairie dog density at Meeteetse was higher than average for white-tailed prairie dogs and because ferrets were taking some alternative prey. Henderson et al. (1979) based on observations of ferrets in South Dakota thought that about 40 ha of black-tailed prairie dog colony were required to support a ferret family, but they noted that ferret litters were raised in colonies as small as 10 ha. However, prairie dog colonies in their study area were being controlled with toxicants and larger colonies may not have been available.

Biggins et al. (1989) developed a model to determine the number of ferret family groups that could be supported by a prairie dog colony. They determined that 763 prairie dogs was the number needed to under typical conditions to support one family group for one year, and that 272.5 prairie dogs was the absolute minimum number of prairie dogs required to support a family group. They calculated ferret group values for each colony and then totaled the number of groups for all colonies in the complex to determine the estimated number of ferrets that a prairie dog complex could support. One problem with this model and a simple interpretation of the Stromberg and Rayburn (1983) energy requirements of a ferret family is that prairie dogs suffer mortality on an annual basis from other factors, and that a certain base population is required to maintain prairie dog reproductive output. These estimates of prairie dogs needed to support ferrets should be considered a minimum estimate, and in fact to maintain a viable ferret population the actual number of prairie dogs required could be considerably higher.

Groves and Clark (1986) estimated that about 200 breeding ferrets are required for a minimal viable population based on genetic considerations. Soule (1987) recommend a 50/500 minimal population size for land vertebrates. Fifty individual were required to prevent gross inbreeding problems and 500 individual were required to assure long-term genetic diversity. Harris et al. (1989) calculated extinction probabilities of ferret populations based on known natality and mortality rates observed at the Meeteetse, Wyoming ferret site. They concluded that a population of 120 individual adult ferrets was required to have a 95% chance of the ferret population surviving 100 years. Based on Hillman et al. (1978) an estimated 4,500 ha of black-tailed prairie dogs would be required to sustain a ferret population of 120 adults, and based on Forrest et al. (1985) about 6,800 ha of white-tailed prairie dogs would be required to sustain a similar ferret population. These are rough estimates and a minimal viable ferret population and the amount of prairie dog habitat needed to support it may vary considerably by geographic region.

When determining suitability of black-footed ferret habitat, the size and distribution of prairie dog colonies is very important. There were only two wild ferret populations studied fairly intensively prior to their extinction. These were a small population in Mellette County in south-central South Dakota and the Meeteetse population in northwestern Wyoming. Although both these populations were in decline when studied, the size and distribution of the prairie dog colonies within the study area was recorded at the time the ferrets were studied. In addition, there was a small ferret population discovered in 1977 near Ekalaka in southeastern Montana for which there is prairie dog colony information (Flath 1978), but no ferret population data. Prairie dog colony attributes and ferret use of these colony complexes is discussed below to provide some information on what minimal ferret habitat might be.

The Mellette population was studied from 1964 to 1974 and during this period ferrets were observed on 14 of 86 (16%) prairie dog colonies (Hillman et al. 1979). These 86 known prairie dog colonies ranged in size from 2 to 120 ha. Mean distance between prairie dog colonies was 2.4 km and the mean distance between ferret occupied colonies was 5.4 km. Although this study did not provide a total acreage figure for prairie dogs within the study area, a map depicting the size and shape of colonies was included in the paper, and a dot grid was used to estimate total size and the percent of the study area occupied. Total prairie dog colony area was estimated at 2,887 ha and the average colony size was about 35.5 ha. This represented about 1.9% of the study area being occupied by prairie dogs. Eleven ferret litters were observed on 9 colonies during the study, and these colonies were 120, 57, 43, 40, 16, 13, 13, 12, 10 ha in size (average 31.2 ha). The authors reported that there were 151 prairie dog colonies within the all of Mellette County and that the average size for these colonies was 8 ha. This would suggest that the actual ferret study area contained larger colonies than the portion of the county not occupied by ferrets. This ferret population went extinct due to recurrent prairie dog control with toxicants.

Ferrets were observed in Ekalaka, Montana in 1977 and 1978 (Flath 1978), and specimen verification of these observations was obtained in 1984 (skeletal material of 2 ferrets)(Anderson et al. 1986). An aerial survey of the area surrounding the ferret occupied colony showed that this was an isolated complex of 20 active prairie dog colonies in 1978 that totaled 908 ha (Flath 1978). However, there were only 11 of these colonies that were within 5 km of each other in the ferret observation area. These colonies totaled 693 ha, and the average colony size was 62.9 ha (range 0.4 to 617 ha). The average distance between colonies based on the legal descriptions supplied by Flath (1978) was 2.7 km. The site of the actual ferret observations was in the 617-ha colony. There was no attempt to study the ferret population in this complex, and the populations went extinct due to deliberate poisoning of the prairie dogs shortly after the discovery of the ferrets.

At the Meeteetse, Wyoming ferret site, ferrets were associated with white-tailed prairie dogs. White-tailed prairie dogs occur at lower densities within their colonies and have correspondingly lower burrow densities as compared to black-tailed prairie dogs (Tileston and Lechleitner 1966). (White-tailed prairie dog density and burrow density are generally less than half that of black-tailed prairie dogs.) Clark et al. (1986) mapped the active white-tailed prairie dog colonies in the complex used by ferrets, and they were also able to estimate colony sizes prior to prairie dog control efforts in the 1930s based on remnant mounds. The Meeteetse complex in the early 1980s contained 37 separate prairie dog colonies, and totaled 2,995 ha. This represented about 9% of the study area being occupied by prairie dogs. The average colony size was 80.9 ha, and colonies ranged in size from 0.5 ha to 738 ha. The average distance between colonies was 0.9 km. The pre-poisoning mapping showed that prairie dogs once occupied about 8,400 ha, or about 25% of the study area. Adult ferrets were observed in 16 colonies (42%) from 1982 to 1984, and the average size of these colonies was 170.7 ha. Litters during this time period were found in only 9 colonies, and the average size of these colonies with litters was 264.9 ha (range 49-738 ha). In 1982 there were 12 litters and 61 ferrets counted in this complex, in 1983, there were 18 litters and 88 ferrets counted, and the known population reached a peak in 1984 with 129 total animals (Weinberg 1986, Forrest et al. 1988). In 1985 the population had dropped to 59 ferrets and it went extinct by February 1987 due to sylvatic plague and/or distemper when the last of 18 surviving ferrets were trapped and removed once it was apparent that ferrets would not survive (Russell et al. 1994).

Table 1 provides a comparison of prairie dog colony attributes at the three complexes with documented ferret populations with prairie dog colony attributes at Grasslands National Park. This review of prairie dog complexes of known ferret populations would suggest that closely spaced prairie dog colonies and the presence of one or more large prairie dog colony are important to ferret survival. At Meeteetse, the number of ferrets occupying the two large core colonies was proportionately greater than the number of ferrets found in adjacent smaller colonies. This would suggest that the greater the area occupied by prairie dogs, the greater the number of ferrets expected in the colony complex. Ferrets at the Ekalaka site appeared to owe their existence one single large colony (693 ha). Other anecdotal information on prairie dogs in this area suggested that there were 10 additional prairie dog colonies in this area, and that the large colony may at one time have been about 1,200 ha. Remnants of at least 5 other large prairie dog colonies (1,000 ha or more) northeast of this area and at adjacent sites in southwestern North Dakota were visible when this area was surveyed in 2002 and 2003. There was an unconfirmed observation of a ferret on one of the large North Dakota colonies in 1973 (Grondahl 1973). Based on a map in Hillman et al. (1978) of prairie dog colonies at the Mellette County complex, there appeared to be a 320-ha colony (estimated), but there was no recorded ferret use of this colony. Their statement of 180 ha being the largest colony may have been in reference to colonies used by ferrets (Hillman et al. 1979). Although the Mellette County complex lacked a singularly large colony, it did contain a large number of closely spaced colonies and about 2% of the landscape was occupied by prairie dogs.

Biggins et al. (1989) defined a prairie dog colony complex as being all colonies within 7 km of each other. They based this distance on the longest recorded nightly movement of black-footed ferrets at Meeteetse (Forrest et al. 1985). However, ferrets typically move considerably less than this (Forrest et al. 1985), and movement through uncolonized areas lacking burrow systems can be a high risk behavior leading to increased predation rates during intercolony travel. Randy Matchett (Pers. Commun. US Fish and Wildlife Service Biologist) has suggested that colony complexes suitable for black-footed ferret reintroductions should be defined by colonies located within 1.5 km of each other. He based this distance on the fact that ferrets rarely travel to adjacent colonies further than this distance. Using this intercolony distance as criteria to define a prairie dog colony complex size greatly reduces the number of colonies and total area occupied by prairie dogs in a complex as opposed to the 7 km complex which seems all inclusive. The 1.5 km prairie dog complex size appears to model more closely the distance factors that are critical to ferrets. It is not a question of how far a ferret can potentially travel in a night, but what distance a ferret can travel between colonies and have reasonable chance of surviving. The smaller the intercolony distances the better the chances of survival.

Reintroduction of black-footed ferrets since 1991 at 11 sites has increased our understanding of what constitutes suitable ferret habitat (Table 2). Only one site, Buffalo Gap National Grassland, has clearly been successful and another site, Shirley Basin, appears that it is in the process of establishing a viable population. Both these sites have large complexes of prairie dog colonies (4,858 ha of black-tailed prairie dogs, 13,765 ha of white-tailed prairie dogs, respectively) located within 1.5 km of each other (Table 2). Another hopeful site is the Cheyenne River Sioux Reservation with 2,024-ha and 3,239-ha complexes. All prairie dog complexes with less than 1,000 ha of prairie dogs appear to have failed to establish a viable populations. The black-tailed prairie dog complex in Mexico has recently suffered from severe drought and few prairie dogs remain. The Aubrey Valley site was a large Gunnison's prairie dog complex that has failed to produce a viable population, but plague may be a factor. For the other reintroduction sites, it may be too early to determine success or failure.

Environmental stochasticity in the form of catastrophic events has been evident at both of the two apparently successful reintroduction sites. At the Buffalo Gap National Grassland site, nearly all of the prairie dog colonies on private land and over a 1,000 ha of prairie dogs on public land were poisoned during the fall of 2004. Some ferrets were trapped and removed where the poisoning threatened their survival, and this activity undoubtedly influenced the 2004 population estimate. At Shirley Basin, a documented plague epizootic occurred early in the reintroduction effort at which point ferret releases were ended in 1994 (Table 2). Ferrets survived this epizootic in low numbers and in recent years have increased substantially without additional releases of captive-raised ferrets.

The black-footed ferret reintroduction effort illustrates that ferret reintroduction requires large complex sizes (about 5,000 ha or more), and repeated releases. It also shows that catastrophic events such as drought, prairie dog control and plague can significantly influence reintroduction results. Catastrophic events (disease and poisoning) also led to the demise of the last three known wild ferret populations, and further illustrates that small populations are extremely vulnerable to environmental stochasticity. For small prairie dog complexes (1,000-2,000 ha), it appears that a viable ferret population can not reasonably be expected to result from reintroduction. Both the Fort Belknap Reservation and UL Bend National Wildlife Refuge had large densely populated black-tailed prairie dog colonies at the release sites, but no connectivity to other prairie dog colonies. Both ferret populations were unable to maintain their numbers without annual releases of captive-raised ferrets. In fact, these populations never achieved the requisite minimum of 50 adult ferrets to avoid severe inbreeding (Soule 1987). Ferrets are no longer found at the Fort Belknap site, and ferrets at the UL Bend site would have gone extinct following three years of no releases (2000-2002) had not additional ferrets been released in 2003. At smaller isolated prairie dog complexes it appears that reintroduced ferret populations may be viable only through periodic releases.

Richardson's ground squirrels are present in Grasslands National Park and it is possible that ferrets could make use of colonies of this species. Support for this possibility comes from Saskatchewan black-footed ferret specimens collected outside of the range of black-tailed prairie dogs. It is possible that Richardson's ground squirrel colonies could provide additional low quality habitat for ferrets and make inter-prairie dog colony travel less hazardous. However, Richardson's ground squirrels are about half the body mass of black-tailed prairie dogs and the diameter of their burrows are proportionately smaller. This size difference may be just enough to be problematic for ferrets in Richardson's ground squirrel burrow systems. Moreover, at the Fort Belknap ferret reintroduction site, Richardson's ground squirrels were present, and there was no evidence that ferrets made use of ground squirrel colonies nor did ground squirrels change the results of the reintroduction effort.

Disease and Predation

Disease has been a significant factor in the decline of black-footed ferrets. The extirpation of black-footed ferrets from the Meeteetse, Wyoming site was due to canine distemper virus (CDV) and possibly an epizootic of plague (Weinberg 1986, Russell et al. 1994). Ferrets are known to be highly susceptible to CDV with a mortality rate approaching 100% (Carpenter 1985). Innocculation of four ferrets taken from the wild South Dakota ferret population with modified-live CDV vaccines resulted in four fatalities at the Patuxent Wildlife Research Center's captive breeding facility (Carpenter 1985). An inactivated CDV virus has proved effective at providing short-term immunity to CDV, but requires semi-annual vaccinations. A new modified live CDV vaccine has proved effective in providing long-term protection to CDV for fur farm mink (US FWS 1990).

Plague has been known to kill captive-raised ferrets and may be equally lethal as CDV to wild ferrets. Plague was introduced to North America around 1900 (Cully 1989), and prairie dogs and ferrets have relatively little immunity to this exotic disease (Cully 1989). Plague typically occurs in black-tailed prairie dog complex as periodic epizootics and can drastically reduce prairie dog numbers within a complex within a few months. Plague has an added impact to ferrets in that it typically removes more than 90% of the prairie dogs in a colony. Even if a ferret survives a plague epizotic, the ferret prey base is so drastically reduced it would be difficult for a ferret to survive in a plague impacted prairie dog colony. In addition, there is a high probability that adjacent colonies would be similarly impacted leaving ferrets with almost complete loss of habitat. Plague may also be persistent and occur in low levels in the environment, and may help account for some of the failures to reintroduce ferrets (Randy Matchett, US Fish and Wildlife Service Biologist, pers. commun.). Dusting prairie dog burrows with 0.5% permethrin dust has proven effective in providing control of fleas (plague vector) in prairie dog burrows (Beard et al. 1992), and has the potential to stop a plague epizootic within a colony or series of colonies. Dusting prairie dog burrows, however, is labor intensive. A plague vaccine for prairie dogs with oral delivery on grain bait is in an experimental stage.

At the Meeteetse ferret site, coyotes (*Canis latrans*) appeared to be the primary predator of black-footed ferrets. However, one ferret was taken by a golden eagle (*Aquila chrysaetos*) and another ferret appeared to have been killed by a bobcat (*Felis rufus*). Ferrets have also been found in golden eagle nests

(Henderson et al. 1974). At reintroduction sites, coyotes can take a significant number of captive-raised ferrets. Electric mesh fencing placed around the colonies where ferrets are released has proven to be effective at preventing coyote predation within the fenced areas (Randy Matchett, US Fish and Wildlife Service Biologist, pers. commun.). One ferret at the Fort Belknap reintroduction site was known to have been taken by a great-horned owl (*Bubo virginianus*). Despite being common in prairie dog colonies, there is little evidence that badgers (*Taxidea taxus*) are a significant predator on ferrets (Randy Matchett, US Fish and Wildlife Service Biologist, pers. commun.). At the Fort Belknap reintroduction site, badgers as well as coyotes were intensively controlled at the reintroduction site, and survival of released ferrets remained low.

Grasslands National Park Ferret Reintroduction Potential

The current prairie dog population at Grasslands National Park is not adequate to support a black-footed ferret reintroduction. Based on other attempts to release ferrets at complexes of about 1,000 ha (defined by 1.5 km) there is little chance that ferrets will develop a viable population. However, the total number of prairie dog colonies and area occupied by prairie dogs in Grasslands National Park is within the range of prairie dog abundance at the last three known wild ferret populations. It is recognized that these populations were in decline at the time of their discovery and may not have been viable. However, all three wild populations went extinct due to catastrophic events (disease and poisoning). Poisoning would not be an issue at Grasslands National Park and there is now sufficient information to deal with the disease issue. Should Grasslands National Park develop additional prairie dog colonies strategically placed between existing colonies and develop one or two large core colonies in the range of 500-1000 ha that would be capable of supporting multiple ferret families, the probability of supporting a successful reintroduction of black-footed ferrets would be greatly increased.

Table 1. Comparison of three prairie dog colony complexes with documented ferret populations with the Grasslands National Park prairie dog complex. (Areas are in hectares.)

Black-footed Ferret Population	No. of Colonies	Total Area of Colonies	Average Colony Size	Ave. KM Between Colonies	% of Area Occupied
Meeteetse, WY	37	2995	80.9	0.9	9.0
Mellette Co., SD	86	2887	35.5	2.4	1.9
Ekalaka, MT	11	693	62.9	2.7	3.5
Grasslands NP	25	1047	41.8	1.9	2.1

Table 2. Summary of black-footed ferret reintroduction efforts at 10 sites.

Site	PD Species	Complex Size (ha)	Release Years	No. Released	Estimated Population
Shirley Basin	WT	13,765	1991-1994	204	96
UL Bend NW	BT	729	1994-2003	202	17
Ft. Belknap	BT	567	1997-2000	167	0
BLM 40-Complex	BT	486	2001-2004	45	10
Badlands NP	BT	405	1994-1999	175	0
Buffalo Gap NG	BT	4,858	1996-1999	150	206
Cheyenne R. Sioux	BT	2,024	2000-2004	189	67
		3,239			
Rosebud	BT	n.a.	2003-2004	69	33
Aubrey Valley	Gun	10,121	1996-2004	173	24
BLM CO	WT	n.a.	1999-2004	156	6
Utah	WT	n.a.	1999-2004	168	20
Janos MX	BT	14,170	2001-2003	219	10

Appendix 2: Simulation Modeling and Population Viability Analysis

Jon Ballou – Smithsonian Institution / National Zoological Park
Bob Lacy – Chicago Zoological Society
Phil Miller – Conservation Breeding Specialist Group (IUCN / SSC)

A model is any simplified representation of a real system. We use models in all aspects of our lives, in order to: (1) extract the important trends from complex processes, (2) permit comparison among systems, (3) facilitate analysis of causes of processes acting on the system, and (4) make predictions about the future. A complete description of a natural system, if it were possible, would often decrease our understanding relative to that provided by a good model, because there is "noise" in the system that is extraneous to the processes we wish to understand. For example, the typical representation of the growth of a wildlife population by an annual percent growth rate is a simplified mathematical model of the much more complex changes in population size. Representing population growth as an annual percent change assumes constant exponential growth, ignoring the irregular fluctuations as individuals are born or immigrate, and die or emigrate. For many purposes, such a simplified model of population growth is very useful, because it captures the essential information we might need regarding the average change in population size, and it allows us to make predictions about the future size of the population. A detailed description of the exact changes in numbers of individuals, while a true description of the population, would often be of much less value because the essential pattern would be obscured, and it would be difficult or impossible to make predictions about the future population size.

In considerations of the vulnerability of a population to extinction, as is so often required for conservation planning and management, the simple model of population growth as a constant annual rate of change is inadequate for our needs. The fluctuations in population size that are omitted from the standard ecological models of population change can cause population extinction, and therefore are often the primary focus of concern. In order to understand and predict the vulnerability of a wildlife population to extinction, we need to use a model which incorporates the processes which cause fluctuations in the population, as well as those which control the long-term trends in population size (Shaffer 1981). Many processes can cause fluctuations in population size: variation in the environment (such as weather, food supplies, and predation), genetic changes in the population (such as genetic drift, inbreeding, and response to natural selection), catastrophic effects (such as disease epidemics, floods, and droughts), decimation of the population or its habitats by humans, the chance results of the probabilistic events in the lives of individuals (sex determination, location of mates, breeding success, survival), and interactions among these factors (Gilpin and Soulé 1986).

Models of population dynamics which incorporate causes of fluctuations in population size in order to predict probabilities of extinction, and to help identify the processes which contribute to a population's vulnerability, are used in "Population Viability Analysis" (PVA) (Lacy 1993/4). For the purpose of predicting vulnerability to extinction, any and all population processes that impact population dynamics can be important. Much analysis of conservation issues is conducted by largely intuitive assessments by biologists with experience with the system. Assessments by experts can be quite valuable, and are often contrasted with "models" used to evaluate population vulnerability to extinction. Such a contrast is not valid, however, as *any* synthesis of facts and understanding of processes constitutes a model, even if it is a mental model within the mind of the expert and perhaps only vaguely specified to others (or even to the expert himself or herself).

A number of properties of the problem of assessing vulnerability of a population to extinction make it difficult to rely on mental or intuitive models. Numerous processes impact population dynamics, and many of the factors interact in complex ways. For example, increased fragmentation of habitat can make it more difficult to locate mates, can lead to greater mortality as individuals disperse greater distances across unsuitable habitat, and can lead to increased inbreeding which in turn can further reduce ability to attract mates and to survive. In addition, many of the processes impacting population dynamics are intrinsically probabilistic, with a random component. Sex determination, disease, predation, mate acquisition -- indeed, almost all events in the life of an individual -- are stochastic events, occurring with certain probabilities rather than with absolute certainty at any given time. The consequences of factors influencing population dynamics are often delayed for years or even generations. With a long-lived species, a population might persist for 20 to 40 years beyond the emergence of factors that ultimately cause extinction. Humans can synthesize mentally only a few factors at a time, most people have difficulty assessing probabilities intuitively, and it is difficult to consider delayed effects. Moreover, the data needed for models of population dynamics are often very uncertain. Optimal decision-making when data are uncertain is difficult, as it involves correct assessment of probabilities that the true values fall within certain ranges, adding yet another probabilistic or chance component to the evaluation of the situation.

The difficulty of incorporating multiple, interacting, probabilistic processes into a model that can utilize uncertain data has prevented (to date) development of analytical models (mathematical equations developed from theory) which encompass more than a small subset of the processes known to affect wildlife population dynamics. It is possible that the mental models of some biologists are sufficiently complex to predict accurately population vulnerabilities to extinction under a range of conditions, but it is not possible to assess objectively the precision of such intuitive assessments, and it is difficult to transfer that knowledge to others who need also to evaluate the situation. Computer simulation models have increasingly been used to assist in PVA. Although rarely as elegant as models framed in analytical equations, computer simulation models can be well suited for the complex task of evaluating risks of extinction. Simulation models can include as many factors that influence population dynamics as the modeler and the user of the model want to assess. Interactions between processes can be modeled, if the nature of those interactions can be specified. Probabilistic events can be easily simulated by computer programs, providing output that gives both the mean expected result and the range or distribution of possible outcomes. In theory, simulation programs can be used to build models of population dynamics that include all the knowledge of the system which is available to experts. In practice, the models will be simpler, because some factors are judged unlikely to be important, and because the persons who developed the model did not have access to the full array of expert knowledge.

Although computer simulation models can be complex and confusing, they are precisely defined and all the assumptions and algorithms can be examined. Therefore, the models are objective, testable, and open to challenge and improvement. PVA models allow use of all available data on the biology of the taxon, facilitate testing of the effects of unknown or uncertain data, and expedite the comparison of the likely results of various possible management options.

PVA models also have weaknesses and limitations. A model of the population dynamics does not define the goals for conservation planning. Goals, in terms of population growth, probability of persistence, number of extant populations, genetic diversity, or other measures of population performance must be defined by the management authorities before the results of population modeling can be used. Because the models incorporate many factors, the number of possibilities to test can seem endless, and it can be difficult to determine which of the factors that were analyzed are most important to the population dynamics. PVA models are necessarily incomplete. We can model only those factors which we understand and for which we can specify the parameters. Therefore, it is important to realize that the models probably underestimate the threats facing the population. Finally, the models are used to predict the long-term effects of the processes presently acting on the population. Many aspects of the situation could change radically within the time span that is modeled. Therefore, it is important to reassess the data and model results periodically, with changes made to the conservation programs as needed (see Lacy and Miller (2002), Nyhus et al. (2002) and Westley and Miller (2003) for more details).

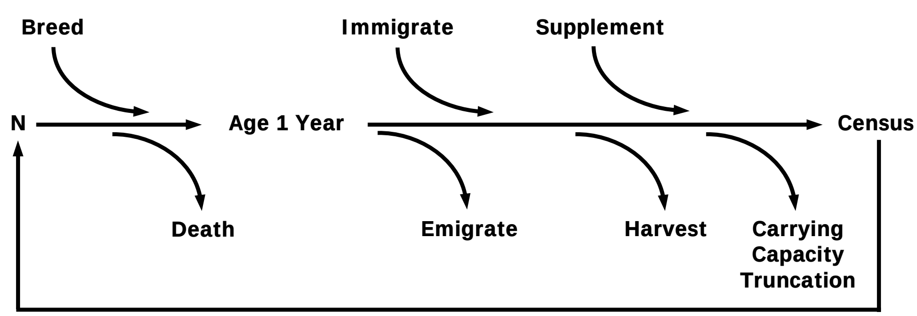
The *VORTEX* Population Viability Analysis Model

For the analyses presented here, the *VORTEX* computer software (Lacy 1993a) for population viability analysis was used. *VORTEX* models demographic stochasticity (the randomness of reproduction and deaths among individuals in a population), environmental variation in the annual birth and death rates, the impacts of sporadic catastrophes, and the effects of inbreeding in small populations. *VORTEX* also allows analysis of the effects of losses or gains in habitat, harvest or supplementation of populations, and movement of individuals among local populations.

Density dependence in mortality is modeled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. The carrying capacity can be specified to change linearly over time, to model losses or gains in the amount or quality of habitat. Density dependence in reproduction is modeled by specifying the proportion of adult females breeding each year as a function of the population size.

VORTEX models loss of genetic variation in populations, by simulating the transmission of alleles from parents to offspring at a hypothetical genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. During the simulation, *VORTEX* monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or "expected heterozygosity") relative to the starting levels. *VORTEX* also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

VORTEX Simulation Model Timeline



Events listed above the timeline increase N, while events listed below the timeline decrease N.

VORTEX is an *individual-based* model. That is, *VORTEX* creates a representation of each animal in its memory and follows the fate of the animal through each year of its lifetime. *VORTEX* keeps track of the sex, age, and parentage of each animal. Demographic events (birth, sex determination, mating, dispersal, and death) are modeled by determining for each animal in each year of the simulation whether any of the events occur. (See figure above.) Events occur according to the specified age and sex-specific probabilities. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether

each demographic event occurs for any given animal.
VORTEX requires a lot of population-specific data. For example, the user must specify the amount of annual variation in each demographic rate caused by fluctuations in the environment. In addition, the frequency of each type of catastrophe (drought, flood, epidemic disease) and the effects of the catastrophes on survival and reproduction must be specified. Rates of migration (dispersal) between each pair of local populations must be specified. Because *VORTEX* requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalized life history. It is most usefully applied to the analysis of a specific population in a specific environment.

Further information on *VORTEX* is available in Lacy (2000) and Miller and Lacy (2003).

Dealing with Uncertainty

It is important to recognize that uncertainty regarding the biological parameters of a population and its consequent fate occurs at several levels and for independent reasons. Uncertainty can occur because the parameters have never been measured on the population. Uncertainty can occur because limited field data have yielded estimates with potentially large sampling error. Uncertainty can occur because independent studies have generated discordant estimates. Uncertainty can occur because environmental conditions or population status have been changing over time, and field surveys were conducted during periods which may not be representative of long-term averages. Uncertainty can occur because the environment will change in the future, so that measurements made in the past may not accurately predict future conditions.

Sensitivity testing is necessary to determine the extent to which uncertainty in input parameters results in uncertainty regarding the future fate of the pronghorn population. If alternative plausible parameter values result in divergent predictions for the population, then it is important to try to resolve the uncertainty with better data. Sensitivity of population dynamics to certain parameters also indicates that those parameters describe factors that could be critical determinants of population viability. Such factors are therefore good candidates for efficient management actions designed to ensure the persistence of the population.

The above kinds of uncertainty should be distinguished from several more sources of uncertainty about the future of the population. Even if long-term average demographic rates are known with precision, variation over time caused by fluctuating environmental conditions will cause uncertainty in the fate of the population at any given time in the future. Such environmental variation should be incorporated into the model used to assess population dynamics, and will generate a range of possible outcomes (perhaps represented as a mean and standard deviation) from the model. In addition, most biological processes are inherently stochastic, having a random component. The stochastic or probabilistic nature of survival, sex determination, transmission of genes, acquisition of mates, reproduction, and other processes preclude exact determination of the future state of a population. Such demographic stochasticity should also be incorporated into a population model, because such variability both increases our uncertainty about the future and can also change the expected or mean outcome relative to that which would result if there were no such variation. Finally, there is “uncertainty” which represents the alternative actions or interventions which might be pursued as a management strategy. The likely effectiveness of such management options can be explored by testing alternative scenarios in the model of population dynamics, in much the same way that sensitivity testing is used to explore the effects of uncertain biological parameters.

Results

Results reported for each scenario include:

Deterministic r -- The deterministic population growth rate, a projection of the mean rate of growth of the population expected from the average birth and death rates. Impacts of harvest, inbreeding, and density dependence are not considered in the calculation. When r = 0, a population with no growth is expected; r < 0 indicates population decline; r > 0 indicates long-term population growth. The value of r is approximately the rate of growth or decline per year.

The deterministic growth rate is the average population growth expected if the population is so large as to be unaffected by stochastic, random processes. The deterministic growth rate will correctly predict future population growth if: the population is presently at a stable age distribution; birth and death rates remain constant over time and space (i.e., not only do the probabilities remain constant, but the actual number of births and deaths each year match the expected values); there is no inbreeding depression; there is never a limitation of mates preventing some females from breeding; and there is no density dependence in birth or death rates, such as a Allee effects or a habitat "carrying capacity" limiting population growth. Because some or all of these assumptions are usually violated, the average population growth of real populations (and stochastically simulated ones) will usually be less than the deterministic growth rate.

Stochastic r -- The mean rate of stochastic population growth or decline demonstrated by the simulated populations, averaged across years and iterations, for all those simulated populations that are not extinct. This population growth rate is calculated each year of the simulation, prior to any truncation of the population size due to the population exceeding the carrying capacity. Usually, this stochastic r will be less than the deterministic r predicted from birth and death rates. The stochastic r from the simulations will be close to the deterministic r if the population growth is steady and robust. The stochastic r will be notably less than the deterministic r if the population is subjected to large fluctuations due to environmental variation, catastrophes, or the genetic and demographic instabilities inherent in small populations.

P(E) -- the probability of population extinction, determined by the proportion of, for example, 500 iterations within that given scenario that have gone extinct in the simulations. "Extinction" is defined in the VORTEX model as the lack of either sex.

N -- mean population size, averaged across those simulated populations which are not extinct.

SD(N) -- variation across simulated populations (expressed as the standard deviation) in the size of the population at each time interval. SDs greater than about half the size of mean N often indicate highly unstable population sizes, with some simulated populations very near extinction. When SD(N) is large relative to N, and especially when SD(N) increases over the years of the simulation, then the population is vulnerable to large random fluctuations and may go extinct even if the mean population growth rate is positive. SD(N) will be small and often declining relative to N when the population is either growing steadily toward the carrying capacity or declining rapidly (and deterministically) toward extinction. SD(N) will also decline considerably when the population size approaches and is limited by the carrying capacity.

H -- the gene diversity or expected heterozygosity of the extant populations, expressed as a percent of the initial gene diversity of the population. Fitness of individuals usually declines proportionately with gene diversity (Lacy 1993b), with a 10% decline in gene diversity typically causing about 15% decline in survival of captive mammals (Ralls et al. 1988). Impacts of inbreeding on wild populations are less well known, but may be more severe than those observed in captive populations (Jiménez et al. 1994). Adaptive response to natural selection is also expected to be proportional to gene diversity. Long-term conservation programs often set a goal of retaining 90% of initial gene diversity (Soulé et al. 1986). Reduction to 75% of gene diversity would be equivalent to one generation of full-sibling or parent-offspring inbreeding.

Appendix 3: IUCN Ex-Situ Guidelines

IUCN Technical Guidelines On the Management of Ex-Situ Populations for Conservation

Approved at the 14th Meeting of the Programme Committee of Council
Gland Switzerland, 10 December 2002

Preamble

IUCN affirms that a goal of conservation is the maintenance of existing genetic diversity and viable populations of all taxa in the wild in order to maintain biological interactions, ecological processes and function. Conservation managers and decision-makers should adopt a realistic and integrated approach to conservation implementation. The threats to biodiversity in situ continue to expand, and taxa have to survive in increasingly human-modified environments. Threats, which include habitat loss, climate change, unsustainable use, and invasive and pathogenic organisms, can be difficult to control. The reality of the current situation is that it will not be possible to ensure the survival of an increasing number of threatened taxa without effectively using a diverse range of complementary conservation approaches and techniques including, for some taxa, increasing the role and practical use of ex situ techniques.

If the decision to bring a taxon under ex situ management is left until extinction is imminent, it is frequently too late to effectively implement, thus risking permanent loss of the taxon. Moreover, ex situ conservation should be considered as a tool to ensure the survival of the wild population. Ex situ management should be considered only as an alternative to the imperative of in situ management in exceptional circumstances, and effective integration between in situ and ex situ approaches should be sought wherever possible.

The decision to implement an ex situ conservation program as part of a formalised conservation management or recovery plan and the specific design of and prescription for such an ex situ program will depend on the taxon's circumstances and conservation needs. A taxon-specific conservation plan may involve a range of ex situ objectives, including short-, medium- and long-term maintenance of ex situ stocks. This can utilise a variety of techniques including reproduction propagation, germplasm banking, applied research, reinforcement of existing populations and re-introduction into the wild or controlled environments. The objectives and overall purpose should be clearly stated and agreed among organisations participating in the program, and other relevant stakeholders including landowners and users of the taxon involved. In order to maximise their full potential in conservation, ex situ facilities and their co-operative networks should adopt the guidelines defined by the Convention on Biological Diversity (CBD), the International Agenda for Botanic Gardens in Conservation, Center for Plant Conservation and the World Zoo Conservation Strategy, along with other guidelines, strategies, and relevant legislative requirements at national and regional levels. IUCN recognizes the considerable set of resources committed worldwide to ex situ conservation by the world's zoological and botanical gardens, gene banks and other ex situ facilities. The effective utilisation of these resources represents an essential component of conservation strategies at all levels.

Vision

To maintain present biodiversity levels through all available and effective means including, where appropriate, ex situ propagation, translocation and other ex situ methodologies.

Goal

Those responsible for managing ex situ plant and animal populations and facilities will use all resources and means at their disposal to maximise the conservation and utilitarian values of these populations, including:

1) increasing public and political awareness and understanding of important conservation issues and the significance of extinction;
2) co-ordinated genetic and demographic population management of threatened taxa;
3) re-introduction and support to wild populations;
4) habitat restoration and management;
5) long-term gene and biomaterial banking;
6) institutional strengthening and professional capacity building;
7) appropriate benefit sharing;
8) research on biological and ecological questions relevant to in situ conservation; and
9) fundraising to support all of the above.

Ex situ agencies and institutions must follow national and international obligations with regard to access and benefit sharing (as outlined in the CBD) and other legally binding instruments such as CITES, to ensure full collaboration with all range States. Priority should be given to the ex situ management of threatened taxa (according to the latest IUCN Red List Categories) and threatened populations of economic or social/cultural importance. Ex situ programmes are often best situated close to or within the ecogeographic range of the target taxa and where possible within the range State. Nevertheless a role for international and extra regional support for ex situ conservation is also recognised. The option of locating the ex situ program outside the taxa's natural range should be considered if the taxa is threatened by natural catastrophes, political and social disruptions, or if further germplasm banking, propagation, research, isolation or reintroduction facilities are required and cannot be feasibly established. In all cases, ex situ populations should be managed in ways that minimize the loss of capacity for expression of natural behaviors and loss of ability to later again thrive in natural habitats.

Technical Guidelines

The basis for responsible ex situ population management in support of conservation is founded on benefits for both threatened taxa and associated habitats.

- The primary objective of maintaining ex situ populations is to help support the conservation of a threatened taxon, its genetic diversity, and its habitat. Ex situ programs should give added value to other complementary programs for conservation.
  Although there will be taxa-specific exceptions due to unique life histories, the decision to initiate ex situ programs should be based on one or more of the appropriate IUCN Red List Criteria, including:

  1. When the taxa/population is prone to effects of human activities or stochastic events or
  2. When the taxa/population is likely to become Critically Endangered, Extinct in the Wild, or Extinct in a very short time. Additional criteria may need to be considered in some cases where taxa or populations of cultural importance, and significant economic or scientific importance, are threatened. All Critically Endangered and Extinct in the Wild taxa should be subject to ex situ management to ensure recovery of wild populations.

- Ex situ conservation should be initiated only when an understanding of the target taxon's biology and ex situ management and storage needs are at a level where there is a reasonable probability that successful enhancement of species conservation can be achieved; or where the development of such protocols could be achieved within the time frame of the taxon's required conservation management, ideally before the taxa becomes threatened in the wild. Ex situ institutions are strongly urged to develop ex situ protocols prior to any forthcoming ex situ management. Consideration must be given to institutional viability before embarking on a long term ex situ project.

- For those threatened taxa for which husbandry and/or cultivation protocols do not exist, surrogates of closely related taxa can serve important functions, for example in research and the development of protocols, conservation biology research, staff training, public education and fundraising.

- While some ex situ populations may have been established prior to the ratification of the CBD, all ex situ and in situ populations should be managed in an integrated, multidisciplinary manner, and where possible, in accordance with the principles and provisions of the CBD.

- Extreme and desperate situations, where taxa/populations are in imminent risk of extinction, must be dealt with on an emergency basis. This action must be implemented with the full consent and support of the range State.

- All ex situ populations must be managed so as to reduce risk of loss through natural catastrophe, disease or political upheaval. Safeguards include effective quarantine procedures, disease and pathogen monitoring, and duplication of stored germplasm samples in different locations and provision of emergency power supplies to support collection needs (e.g. climate control for long term germplasm repositories).

- All ex situ populations should be managed so as to reduce the risk of invasive escape from propagation, display and research facilities. Taxa should be assessed as to their invasive potential and appropriate controls taken to avoid escape and subsequent naturalisation.

- The management of ex situ populations must minimise any deleterious effects of ex situ management, such as loss of genetic diversity, artificial selection, pathogen transfer and hybridisation, in the interest of maintaining the genetic integrity and viability of such material. Particular attention should be paid to initial sampling techniques, which should be designed to capture as much wild genetic variability as practicable. Ex situ practitioners should adhere to, and further develop, any taxon- or region-specific record keeping and genetic management guidelines produced by ex situ management agencies.

- Those responsible for managing ex situ populations and facilities should seek both to increase public awareness, concern and support for biodiversity, and to support the implementation of conservation management, through education, fundraising and professional capacity building programs, and by supporting direct action in situ.

- Where appropriate, data and the results of research derived from ex situ collections and ex situ methodologies should be made freely available to ongoing in-country management programs concerned with supporting conservation of in situ populations, their habitats, and the ecosystems and landscapes in which they occur .

NB. Ex situ conservation is defined here, as in the CBD, as "the conservation of components of biological diversity outside their natural habitats". Ex situ collections include whole plant or animal collections, zoological parks and botanic gardens, wildlife research facilities, and germplasm collections of wild and domesticated taxa (zygotes, gametes and somatic tissue).

Appendix 4:
IUCN Ex-Situ Guidelines

IUCN/SSC Guidelines For Re-Introductions

Prepared by the SSC Re-introduction Specialist Group *
Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995

Introduction

These policy guidelines have been drafted by the Re-introduction Specialist Group of the IUCN's Species Survival Commission (1), in response to the increasing occurrence of re-introduction projects worldwide, and consequently, to the growing need for specific policy guidelines to help ensure that the re-introductions achieve their intended conservation benefit, and do not cause adverse side-effects of greater impact. Although IUCN developed a Position Statement on the Translocation of Living Organisms in 1987, more detailed guidelines were felt to be essential in providing more comprehensive coverage of the various factors involved in re-introduction exercises.

These guidelines are intended to act as a guide for procedures useful to re-introduction programmes and do not represent an inflexible code of conduct. Many of the points are more relevant to re-introductions using captive-bred individuals than to translocations of wild species. Others are especially relevant to globally endangered species with limited numbers of founders. Each re-introduction proposal should be rigorously reviewed on its individual merits. It should be noted that re-introduction is always a very lengthy, complex and expensive process.

Re-introductions or translocations of species for short-term, sporting or commercial purposes - where there is no intention to establish a viable population - are a different issue and beyond the scope of these guidelines. These include fishing and hunting activities.

This document has been written to encompass the full range of plant and animal taxa and is therefore general. It will be regularly revised. Handbooks for re-introducing individual groups of animals and plants will be developed in future.

Context

The increasing number of re-introductions and translocations led to the establishment of the IUCN/SSC Species Survival Commission's Re-introduction Specialist Group. A priority of the Group has been to update IUCN's 1987 Position Statement on the Translocation of Living Organisms, in consultation with IUCN's other commissions.

It is important that the Guidelines are implemented in the context of IUCN's broader policies pertaining to biodiversity conservation and sustainable management of natural resources. The philosophy for environmental conservation and management of IUCN and other conservation bodies is stated in key documents such as "Caring for the Earth" and "Global Biodiversity Strategy" which cover the broad themes of the need for approaches with community involvement and participation in sustainable natural resource conservation, an overall enhanced quality of human life and the need to conserve and, where necessary, restore ecosystems. With regards to the latter, the re-introduction of a species is one specific instance of restoration where, in general, only this species is missing. Full restoration of an array of plant and animal species has rarely been tried to date.

Restoration of single species of plants and animals is becoming more frequent around the world. Some succeed, many fail. As this form of ecological management is increasingly common, it is a priority for the Species Survival Commission's Re-introduction Specialist Group to develop guidelines so that re-introductions are both justifiable and likely to succeed, and that the conservation world can learn from each initiative, whether successful or not. It is hoped that these Guidelines, based on extensive review of case - histories and wide consultation across a range of disciplines will introduce more rigour into the concepts, design, feasibility and implementation of re-introductions despite the wide diversity of species and conditions involved.

Thus the priority has been to develop guidelines that are of direct, practical assistance to those planning, approving or carrying out re-introductions. The primary audience of these guidelines is, therefore, the practitioners (usually managers or scientists), rather than decision makers in governments. Guidelines directed towards the latter group would inevitably have to go into greater depth on legal and policy issues.

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1. Definition of Terms

"Re-introduction": an attempt to establish a species(2) in an area which was once part of its historical range, but from which it has been extirpated or become extinct (3) ("Re-establishment" is a synonym, but implies that the re-introduction has been successful).

"Translocation": deliberate and mediated movement of wild individuals or populations from one part of their range to another.

"Re-inforcement/Supplementation": addition of individuals to an existing population of conspecifics.

"Conservation/Benign Introductions": an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species' historic range.

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2. Aims And Objectives Of Re-Introduction

a. Aims:
The principle aim of any re-introduction should be to establish a viable, free-ranging population in the wild, of a species, subspecies or race, which has become globally or locally extinct, or extirpated, in the wild. It should be re-introduced within the species' former natural habitat and range and should require minimal long-term management.

b. Objectives:
The objectives of a re-introduction may include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain and/or restore natural biodiversity; to provide long-term economic benefits to the local and/or national economy; to promote conservation awareness; or a combination of these.

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3. Multidisciplinary Approach

A re-introduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds. As well as government personnel, they may include persons from governmental natural resource management agencies; non-governmental organisations; funding bodies; universities; veterinary institutions; zoos (and private animal breeders) and/or botanic gardens, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project.

4. Pre-Project Activities

4a. Biological

(i) Feasibility study and background research

- An assessment should be made of the taxonomic status of individuals to be re-introduced. They should preferably be of the same subspecies or race as those which were extirpated, unless adequate numbers are not available. An investigation of historical information about the loss and fate of individuals from the re-introduction area, as well as molecular genetic studies, should be undertaken in case of doubt as to individuals' taxonomic status. A study of genetic variation within and between populations of this and related taxa can also be helpful. Special care is needed when the population has long been extinct.
- Detailed studies should be made of the status and biology of wild populations(if they exist) to determine the species' critical needs. For animals, this would include descriptions of habitat preferences, intraspecific variation and adaptations to local ecological conditions, social behaviour, group composition, home range size, shelter and food requirements, foraging and feeding behaviour, predators and diseases. For migratory species, studies should include the potential migratory areas. For plants, it would include biotic and abiotic habitat requirements, dispersal mechanisms, reproductive biology, symbiotic relationships (e.g. with mycorrhizae, pollinators), insect pests and diseases. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire re-introduction scheme.
- The species, if any, that has filled the void created by the loss of the species concerned, should be determined; an understanding of the effect the re-introduced species will have on the ecosystem is important for ascertaining the success of the re-introduced population.
- The build-up of the released population should be modelled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population.
- A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term population management.

(ii) Previous Re-introductions

- Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing re-introduction protocol.

(iii) Choice of release site and type

- Site should be within the historic range of the species. For an initial re-inforcement there should be few remnant wild individuals. For a re-introduction, there should be no remnant population to prevent disease spread, social disruption and introduction of alien genes. In some circumstances, a re-introduction or re-inforcement may have to be made into an area which is fenced or otherwise delimited, but it should be within the species' former natural habitat and range.
- A conservation/ benign introduction should be undertaken only as a last resort when no opportunities for re-introduction into the original site or range exist and only when a significant contribution to the conservation of the species will result.
- The re-introduction area should have assured, long-term protection (whether formal or otherwise).

(iv) Evaluation of re-introduction site

- Availability of suitable habitat: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the for-seeable future. The possibility of natural habitat change since extirpation must be considered. Likewise, a change in the legal/ political or cultural environment since species extirpation needs to be ascertained and evaluated as a possible constraint. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.
- Identification and elimination, or reduction to a sufficient level, of previous causes of decline: could include disease; over-hunting; over-collection; pollution; poisoning; competition with or predation by introduced species; habitat loss; adverse effects of earlier research or management programmes; competition with domestic livestock, which may be seasonal. Where the release site has undergone substantial degradation caused by human activity, a habitat restoration programme should be initiated before the re-introduction is carried out.

(v) Availability of suitable release stock

- It is desirable that source animals come from wild populations. If there is a choice of wild populations to supply founder stock for translocation, the source population should ideally be closely related genetically to the original native stock and show similar ecological characteristics (morphology, physiology, behaviour, habitat preference) to the original sub-population.
- Removal of individuals for re-introduction must not endanger the captive stock population or the wild source population. Stock must be guaranteed available on a regular and predictable basis, meeting specifications of the project protocol.
- Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed, and after it is guaranteed that these effects will not be negative.
- If captive or artificially propagated stock is to be used, it must be from a population which has been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.
- Re-introductions should not be carried out merely because captive stocks exist, nor solely as a means of disposing of surplus stock.
- Prospective release stock, including stock that is a gift between governments, must be subjected to a thorough veterinary screening process before shipment from original source. Any animals found to be infected or which test positive for non-endemic or contagious pathogens with a potential impact on population levels, must be removed from the consignment, and the uninfected, negative remainder must be placed in strict quarantine for a suitable period before retest. If clear after retesting, the animals may be placed for shipment.
- Since infection with serious disease can be acquired during shipment, especially if this is intercontinental, great care must be taken to minimize this risk.
- Stock must meet all health regulations prescribed by the veterinary authorities of the recipient country and adequate provisions must be made for quarantine if necessary.

(vi) Release of captive stock

- Most species of mammal and birds rely heavily on individual experience and learning as juveniles for their survival; they should be given the opportunity to acquire the necessary information to enable survival in the wild, through training in their captive environment; a captive bred individual's probability of survival should approximate that of a wild counterpart.

- Care should be taken to ensure that potentially dangerous captive bred animals (such as large carnivores or primates) are not so confident in the presence of humans that they might be a danger to local inhabitants and/or their livestock.

4b. Socio-Economic And Legal Requirements

- Re-introductions are generally long-term projects that require the commitment of long-term financial and political support.
- Socio-economic studies should be made to assess impacts, costs and benefits of the re-introduction programme to local human populations.
- A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss or alteration of habitat). The programme should be fully understood, accepted and supported by local communities.
- Where the security of the re-introduced population is at risk from human activities, measures should be taken to minimise these in the re-introduction area. If these measures are inadequate, the re-introduction should be abandoned or alternative release areas sought.
- The policy of the country to re-introductions and to the species concerned should be assessed. This might include checking existing provincial, national and international legislation and regulations, and provision of new measures and required permits as necessary.
- Re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country. This is particularly important in re-introductions in border areas, or involving more than one state or when a re-introduced population can expand into other states, provinces or territories.
- If the species poses potential risk to life or property, these risks should be minimised and adequate provision made for compensation where necessary; where all other solutions fail, removal or destruction of the released individual should be considered. In the case of migratory/mobile species, provisions should be made for crossing of international/state boundaries.

5. Planning, Preparation And Release Stages

- Approval of relevant government agencies and land owners, and coordination with national and international conservation organizations.
- Construction of a multidisciplinary team with access to expert technical advice for all phases of the programme.
- Identification of short- and long-term success indicators and prediction of programme duration, in context of agreed aims and objectives.
- Securing adequate funding for all programme phases.
- Design of pre- and post- release monitoring programme so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data.

Monitoring the health of individuals, as well as the survival, is important; intervention may be necessary if the situation proves unforseeably favourable.

- Appropriate health and genetic screening of release stock, including stock that is a gift between governments. Health screening of closely related species in the re-introduction area.
- If release stock is wild-caught, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.
- If vaccination prior to release, against local endemic or epidemic diseases of wild stock or domestic livestock at the release site, is deemed appropriate, this must be carried out during the "Preparation Stage" so as to allow sufficient time for the development of the required immunity.
- Appropriate veterinary or horticultural measures as required to ensure health of released stock throughout the programme. This is to include adequate quarantine arrangements, especially where founder stock travels far or crosses international boundaries to the release site.
- Development of transport plans for delivery of stock to the country and site of re-introduction, with special emphasis on ways to minimize stress on the individuals during transport.
- Determination of release strategy (acclimatization of release stock to release area; behavioural training - including hunting and feeding; group composition, number, release patterns and techniques; timing).
- Establishment of policies on interventions (see below).
- Development of conservation education for long-term support; professional training of individuals involved in the long-term programme; public relations through the mass media and in local community; involvement where possible of local people in the programme.
- The welfare of animals for release is of paramount concern through all these stages.

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6. Post-Release Activities

- Post release monitoring is required of all (or sample of) individuals. This most vital aspect may be by direct (e.g. tagging, telemetry) or indirect (e.g. spoor, informants) methods as suitable.
- Demographic, ecological and behavioural studies of released stock must be undertaken.
- Study of processes of long-term adaptation by individuals and the population.
- Collection and investigation of mortalities.
- Interventions (e.g. supplemental feeding; veterinary aid; horticultural aid) when necessary.
- Decisions for revision, rescheduling, or discontinuation of programme where necessary.
- Habitat protection or restoration to continue where necessary.
- Continuing public relations activities, including education and mass media coverage.
- Evaluation of cost-effectiveness and success of re- introduction techniques.
- Regular publications in scientific and popular literature.

Footnotes:

1. Guidelines for determining procedures for disposal of species confiscated in trade are being developed separately by IUCN.
2. The taxonomic unit referred to throughout the document is species; it may be a lower taxonomic unit (e.g. subspecies or race) as long as it can be unambiguously defined.
3. A taxon is extinct when there is no reasonable doubt that the last individual has died

International Black-Footed Ferret Recovery Workshop

Calgary, Alberta, Canada
1 – 4 April, 2005

DRAFT REPORT

Section VIII
References

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